THE AEROPLANE and ASTRONAUTICS

JANUARY 20, 1961

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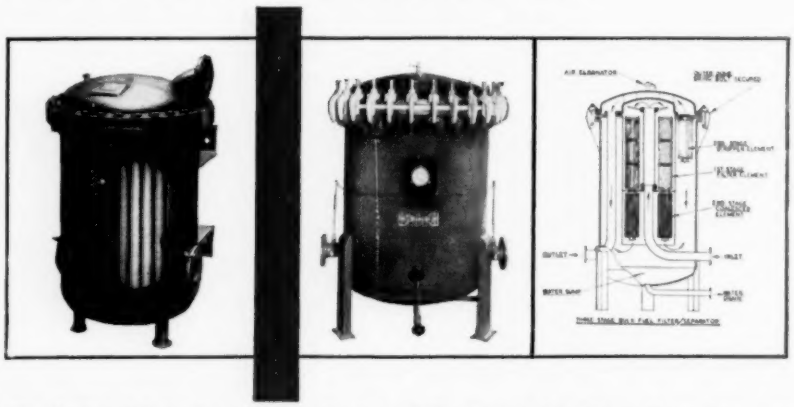

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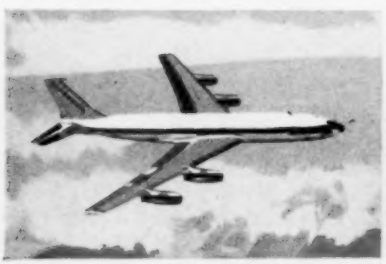

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THE AEROPLANE and ASTRONAUTICS

VOLUME 100 NUMBER 2570 JANUARY 20, 1961

Training the Aero/Space Technologists

Reports from the United States make it apparent that there are many Americans who expect the Russians to put a manned satellite into orbit around the time of the inauguration of the new U.S. President. That such an achievement should be considered imminent is a measure of the progress that has been made in aero-space technology in the past five years. The fact that the British Government still does not have a space programme is a measure of how far the United Kingdom lies behind in this matter.

For some hundreds of years Britain's naval supremacy secured the freedom of the seas for peaceful traffic. It is an interesting reflection that it took an American, Admiral Mahan, to produce the definitive work on the subject.

But so swiftly do events in the modern world move that no American, admiral or air force general, has yet written a work to show that control of the seas and control of the air have been supplanted by supremacy in space. The last-mentioned is but a logical extension of the first two capabilities, though to many people's minds there is still something almost blasphemous about the thought.

One of the most worrying things in such circumstances is the limited capacity in this country of engineering training for would-be aero-space engineers. This, of course, is but the natural outcome of a lack of national policy in the matter.

We welcome therefore the initiative shown by the Department of Aero-space Engineering at the Northampton College of Technology in London in holding a conference recently, one of the objects of which was to focus the attention of educationalists on the gaps existing in this matter. We trust that their efforts to produce a new generation of British aero-space technologists will be successful.

Flying Controls and Safety

Increasingly, interest is being focused here at home upon various aspects of what, for want of a more concise definition, may be called "general aviation." By this we mean all those branches of civil aviation not concerned with public transport. One of its branches is the sport of flying which some think of as just flying for fun. Two extremes in aircraft designed for this, the lesser branch of general aviation, may be exemplified on the one hand by the long-lived Ercoupe of Fred Weick now available as the Aircoupe. On the other there is the attractive, clean-lined sports machine the French-conceived Turbulent—to the minds of many, a diminutive Spitfire.

In the first design effort has been concentrated on producing the safest possible vehicle able to move in three dimensions. Its record has been such as to justify the use of restricted control movements.

In the second machine, control forces on the stick are extremely light. A recent accident has raised the question of whether they are too light for safety. An article in our Personal Flying section discusses the implication.

Is it not possible that safety might be increased, particularly as cleaner, faster designs become available to the private owner, if more attention were paid to the limitation of forces applied to the aircraft, particularly as regards the relationship between forces needed to move the controls and the imposition of *g* loads on the airframe structure?

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Matters of Moment

The Law versus Science

A SUGGESTION that the Royal Aeronautical Society should set up a law reform committee was made by Mr. H. Kaplan on Jan. 11 when he lectured to the Society on "The Law versus Science in Aeronautics." He suggested that the committee should apply aeronautical and allied sciences to the evolution of law.

One of Mr. Kaplan's conclusions was that, to avoid strangling the future of aeronautics with the noose of ancient legal thought, scientists, lawyers and law-makers should find ways to collaborate effectively in identifying essential problems and evolving creative solutions. Failure to do this might have the gravest consequences when preparing the way for explorations beyond the Earth.

Traditionally, he said, there had been little opportunity for direct consultation with scientists in the evolution of law. As a result, the rules of law in aeronautics acted as a serious limiting factor on operations, particularly of supersonic aircraft. Detailed rules should not merely catalogue prohibited evils from the past, but should positively encourage a rational approach to the conduct of aeronautics.

Unless changes can be made in the laws associated with aeronautical activities, Mr. Kaplan felt that many scientific members of the R.Ae.S. might find their future livelihood at stake.

High-level VTOL

POLITICS are so deeply involved in the choice of a new VTOL strike fighter for NATO that the airframe companies concerned are confused by government-to-government decisions made over their heads. Latest of these moves occurred last week when the Minister of Aviation visited West Germany. Following discussions it was announced that "The United Kingdom and the Federal Republic wish to enter into negotiations in the near future for the joint development of a vertical take-off lightweight strike fighter on the basis of the British project P.1127, which is a successor to the Fiat G.91. Other NATO countries will be invited to join in this development project."

Hawker Aircraft has not been involved by this pronouncement as yet. Neither has there been much practical outcome of an earlier government-to-government agreement between Britain and Germany to co-ordinate VTOL aircraft research and development. Many such high-level decisions seem to have little practical result. For example, in December, 1959, it was announced that Britain and Germany would jointly develop the Blue Water corps-support missile. This decision has not yet become effective at company level.

The latest Anglo-German decision on the Hawker P.1127 is puzzling in view of the Franco-German agreement signed on Dec. 19 for joint design and manufacture of a supersonic VTOL fighter. It appears that Germany is interested in both a VTOL replacement for the G.91, which would be the P.1127, and also a VTOL replacement for the Starfighter.

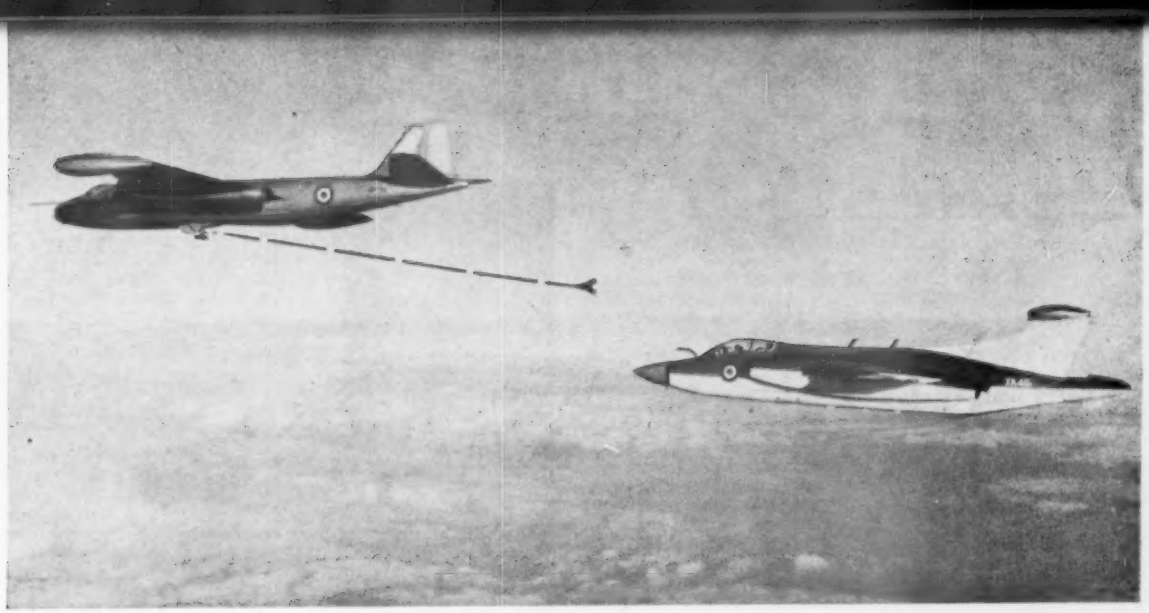
A range of European design studies exists for both subsonic and supersonic VTOL fighters. Both Sud and Dassault have supersonic projects in this category and so do Fokker, in conjunction with Republic, and a German group formed by Messerschmitt, Heinkel and Bölkow. British airframe companies have said little about their ideas, but Hawker, Short and probably English Electric have made design studies.

NATO is to hold a meeting in Paris next month in an attempt to finalize its design specifications for a VTOL fighter. The preliminary requirement called for a cruise speed of Mach 0.92, but this may be increased at the NATO meeting. In view of the many competitive projects, it will probably be a long time before NATO members agree on a standard design.

But so far the only military VTOL aircraft to fly has been the Hawker P.1127. The first supersonic type to do so could well be French. Although British airframe manufacturers appear to be lagging in the supersonic VTOL field, all European projects of this type rely on British engines for jet lift or propulsion or both.

AUTOLAND CONTRACT.—Left to right (seated) Mr. J. L. Anast, director of Research and Development, F.A.A., Mr. K. Fearnside and Mr. A. M. A. Majendie, Smiths Aviation Division with Mr. R. D. Munnikhuysen and Mr. D. J. Sheftel, both of the F.A.A. and Mr. A. G. Stirling, Smiths, behind.

SAVING MONEY.—A British United Airways Westland Widgeon lowering a section of 8-in. bore pipeline on marshy ground near Gravesend. The operation which consisted of laying 1,720 ft. of pipeline took approximately seven hours and cost about £200. With cranes and lorries the project would have taken more than seven days and cost about £1,200.



EXTENDING THE RANGE.—A Blackburn Buccaneer—the Royal Navy's new strike aircraft—has been undergoing evaluation trials of its in-flight refuelling equipment. For these trials, which were made from the Flight Refuelling base at Tarrant Rushton, a Canberra was used as the tanker aircraft.

F.A.A. Autoland Trials

FOLLOWING discussions between the Ministry of Aviation and Mr. E. R. Quesada, Administrator of the U.S. Federal Aviation Agency, in September of last year, the Agency's Bureau of Research and Development is to evaluate the R.A.E.-developed automatic landing system at its National Aviation Facilities Experimental Center, Atlantic City.

The necessary British-manufactured equipment is to be installed in a DC-7 recently acquired by the Agency. The aircraft is at present in New York where it is undergoing autopilot, ILS and other checks and modifications by the Sperry Gyroscope Co., of America. It is expected that it will be flown to the United Kingdom next October for completion and final equipment installation, supervised by Smiths Aviation Division.

Present American ILS equipment and Sperry A-12 autopilot in the DC-7 will be retained with certain modifications, which include the addition of suitable locking and coupling units designed by Smiths and of the Smiths automatic throttle control system. The Standard Telephone STR.30B radio altimeter is to be used, together with the entire airborne and ground components of the Murphy Radio magnetic leader cable installation.

Initial flight trials will be undertaken in this country, presumably at the R.A.E. Bedford, and the DC-7 is expected to return to Atlantic City in March of next year. There, the F.A.A. test and evaluation programme is planned to be completed in from four to six months, so that a decision on the possible future of the system in the United States can be made in October, 1962.

Towards the end of the Atlantic City evaluation programme the F.A.A. will start demonstrating the system to U.S. carriers, including Pan American, United Air Lines and American Airlines. Pan American, in particular, are known to be very keen to become the first civil operator with an automatic landing capability.

The reason for the selection of a DC-7 for the trials is that a number of U.S. operators use this type of transport for their freight services. So, if the system is adopted by the F.A.A., it could first be evaluated in commercial airline operation on non-passenger-carrying flights.

Slush and Take-offs

RESEARCH work on the effects of slush, water and snow on take-off has resulted in guidance material given in Civil Aviation Information Circular No. 8/1961. This circular shows, in numerical terms, that the deterioration of performance is greater than had previously been appreciated.

Generally speaking, the least seriously affected aircraft are those with bogey undercarriages—in which the leading pair of wheels clear the way for the rear pair—and the most seriously affected are those, such as the Ambassador, with low-slung fuselages which suffer from high secondary drag from the spray pattern.

Even so, the Viscount, amongst half a dozen other aircraft, requires an 80% increment to the all-engines take-off field length when the depth of slush or water is 1 in.—which is the normal maximum recommended depth for safe take-off by any aircraft. Dry snow is much less troublesome because it compacts, but a depth of only 4½ in. is the maximum recommended.

Various techniques for reducing the take-off run—such as, in the case of propeller aircraft, raising the nosewheel early and lifting the aircraft off at a speed below that of normal unstick—are discussed in the circular. (It will, incidentally, be noted, by everyone seriously concerned with the problem, that the column for the increments to field lengths in the first table of the circular is headed 0.1 in. instead of 1.0 in.)

Seacats and After

ANNOUNCEMENT of an order by West Germany for 50 Short Seacat surface-to-air missiles was one concrete decision which emerged from Mr. Thorneycroft's visit to Bonn last week. Focke-Wulf has an agreement with Shorts concerning the German evaluation programme and possible joint development of the missile.

Future collaboration on a missile system to intercept low-flying aircraft was also mentioned in the official communique. "The Government of the United Kingdom and the Federal German Republic hold the same views on new weapons for defence against low-flying aircraft. The British Government intends to expand the tripartite co-operation existing in this field between France, Italy and the Federal Republic by participating in this joint effort and thus giving it a broader basis."

The existing co-operation presumably refers to joint production of the Hawker SAM. A British contribution in the future could well be the English Electric project 428. This is believed to be a salvo-launched missile system for the interception of low-flying aircraft; it would replace 40-mm. Bofors cannon. The Mauler is a competitive missile from the U.S.

More Moves in Space Politics

AS we mentioned briefly last week, France is among a number of countries which are negotiating with NASA for facilities to launch home-produced scientific equipment. At present, discussions are in the preliminary stage but officials of the French Commission for Spatial and Scientific Research expect talks to begin in earnest early this year.

This venture, of course, has nothing to do with the U.K./French project to develop Blue Streak as a European heavy satellite launcher, but would merely enable French scientists to participate in space-research much earlier than could otherwise be possible. In the same way, Britain has responded to the NASA offer to launch scientific equipment in the S-51 satellite by means of the American-produced Scout rocket to be launched from Wallops Island, Virginia.

Of the Blue Streak deliberations and Mr. Thorneycroft's recent visits to Bonn and the Scandinavian countries, the Minister made it clear that the British and French Governments wish to be certain "during the next two to three months" whether other countries are likely to be interested in the project. It is proposed to hold a conference to consider "political, technical and commercial" issues at Strasbourg on Jan. 30.

Mr. Thorneycroft emphasized that the Common Market countries and the European Free Trade Association countries and Spain might be interested. It was not primarily a financial matter but rather one of achieving scientific co-operation between the interested countries. In the event of the combined operation going through, several special organizations would

Matters of Moment . . . .

be established to manage it, some in London and some on the Continent.

Mr. Thorneycroft said the total cost of the project would be about £70m. In the case of Denmark, for example, the contribution would be a little more than £300,000 a year for five years.

Asked at a Press conference whether Britain would proceed with the scheme alone if insufficient support were obtained from other European countries, Mr. Thorneycroft replied: "We will consider that eventuality when it arises."

Skybolt Through the Looking-glass

A SHORT air-to-air film of the new Boeing B.52 Skybolt-carrier in flight seen last week on several million television screens must have led several million viewers nicely up the ballistic missile path. According to the commentary the missile-like objects beneath its wings were identical to real Skybolts except that they did not have atomic warheads. Considering that the test—also according to the commentary—was to prove that the aircraft's wings were strong enough to carry Skybolt, this vital difference shows commendable caution.

What the commentary might have explained to the megasized audience was that for such a straightforward purpose, appropriately shaped lumps of any suitable material having the same density as the missile would have sufficed. In other releases of Skybolt information (which have followed remarkably quickly on the reports from America that there had been a cut-back in expenditure on this highly classified missile) there have been photographs of the B.52H on the ground carrying test "models" of the weapon.

The film was clearly another step in the same series and there is no reason to suppose that the objects under the wings of the aircraft seen in the air were in fact any different from those seen in the previous stills. In fact, to suggest otherwise was so misleading a piece of propaganda that to the better-informed members of the vast audience it tended to confirm their worst fears about the future of an, at present, non-existent weapon that has been selected for a leading place in Britain's deterrent armoury.

Electra Troubles Explained

WING FLUTTER induced by propeller "whirl mode" is given as the reason for structural failure of Lockheed Electra airliners in an F.A.A. report issued on Jan. 5.

The Electra wing has good positive damping which inherently prevents flutter. This was proved during a revaluation of Electra strength and stressing which involved over a million engineering man hours by Lockheed, Allison, NASA and the F.A.A. An extensive gust flight programme was also made.

These studies and tests showed that although the control system of the Electra could not induce wing oscillation, the wobbling of an outboard propeller could. Such wobbling could only occur following certain structural failures.

A propeller has gyroscopic characteristics and will tend to stay in its plane of rotation even though loosely mounted and will do so unless displaced by a strong external force such as atmospheric turbulence, an abrupt aircraft manœuvre or a sudden engine power surge. When such a force is applied, the propeller reacts 90° out of phase with it.

If the propeller is displaced upward by a force, the structural resistance of the mounting applies a nose-down pitching moment. The propeller disc, when viewed from the rear, will then turn to the left due to precession. The yaw stiffness then causes a nose-down pitching moment, which in turn is resisted structurally, resulting in the propeller disc yawing to the right; the yaw stiffness on that side causes a nose-up pitch to complete the cycle. This effect is called the "whirl mode"; it rotates in the opposite direction to that of the propeller.

Normally the "whirl mode" can operate only within the flexibility limits of the engine mountings and it is damped out quickly. But if the stiffness of the propeller-support system is reduced by structural weakness or weakness in the powerplant or nacelle structure, the "whirl mode" will not damp out rapidly at high speed.

In a damaged and weak structure the "whirl mode" frequency could be reduced from its natural frequency to lower values which approach the wing natural frequencies. This could set up induced flutter at a lower airspeed than that at which classical wing flutter would develop. Flutter of this type caused the Electra failures.

As a result of this diagnosis Electras are being modified and will again be allowed to fly at their design speed of 373 m.p.h. A restriction to 259 m.p.h. was applied after the crashes.

The modifications are additional mountings to stabilize the propeller if any mount should fail or breakage occur between the gearbox and power section. The nacelle structure has been strengthened considerably by the addition of reinforcements and diagonal members. Wing strength has been improved by increasing the thickness of three lower-surface "planks" and an upper-surface one; by reinforcing the front spars and the wing lower surface; and by strengthening 18 ribs in each wing.

A stringent flight test programme has proved the effect of these modifications. The F.A.A. required that the severest conceivable structural failure should be simulated; this was failure of the torque shaft and its housing. These were removed before flight and in its weakened state the aircraft was dived at speeds up to 418 m.p.h. Severe flight loads were imposed by the pilot. The whirl phenomenon and any other adverse effects were completely absent.

The tests included endurance flying and a 100-hr. programme of run-ups, take-offs and landings, coupled with high-speed dives, to prove the effect of the new mounts on engine wear.

NOW FOR THE LORDS.—Mr. G. S. Lindgren well known in aviation as Parliamentary Secretary to the Ministry of Civil Aviation from 1946 to 1950 who has been awarded a life peerage.

U.S. Space-programme Reviewed

FINDINGS of the nine-man "task-force" set up by Mr. Kennedy, the President-elect, to inquire into the status of U.S. missile and space programmes has been highly critical of the space policies laid down by the outgoing Eisenhower administration. Headed by Dr. Jerome B. Wiesner, of the Massachusetts Institute of Technology, the committee has stated categorically that "it is very unlikely" that America will be the first nation to send a man into orbit.

Among other conclusions are that the nation's ballistic missile programme is lagging, partly because the Pentagon and industry appear to be more interested in "vast new space projects." There are apparently still too many agencies trying to develop independent space programmes, including those old rivals the Army, Navy and Air Force.

All military programmes, the committee says, should be assigned to one agency or military service within the Defense Department. It is also felt that NASA should undergo major revisions to include a "vigorous, imaginative, and technically competent top management." The following positions were especially emphasized: Administrator and Deputy Administrator; and technical directors for:—propulsion and vehicles; the "scientific" programme; non-military space-applications; and aerodynamic and aircraft programmes.

Another point was that Russia had gained more prestige in space because it possessed the World's most powerful rocket boosters. In the light of this situation, the United States must undertake "the rapid development of boosters with a great weight-lifting capacity as a matter of national urgency."

It was therefore necessary to review and redefine the objectives of the national space programme on the basis of experience gained during the past two years. Particular attention should be given to boosters, manned spaceflight, the military uses of space, and the applications of space technology to the civilian activities of the country.

To achieve this end, the government must help industry with tools and money in "a vigorous programme" to develop non-military aspects of space, such as communications, navigation and weather-predicting aids. The conclusion, therefore, was that the organizational machinery must be established within the government to administer an industry-government civilian space-programme.

The committee also sounded a warning note on the status of basic research and development in aeronautics. NASA nowadays gives little attention in its organization to this aspect and there was a general belief in the aviation industry that the national preoccupation with space developments had all but halted any advance in the theory and technology of aerodynamic flight.

"There is ample evidence," the report concludes, "to support the contention that the Russians and possibly the British, are surpassing us in this field and consequently in the development of supersonic commercial aircraft."

Training Aero/Space Engineers

HEAD of the Department of Aeronautical Engineering at the Northampton College of Advanced Technology, London, Dr. G. A. Tokaty, D.Eng.(Mech.), Doc.Ae.Sc., Can.Tech.Sc., A.F.R.Ae.S., A.F.I.A.S., recently returned to this country after a year in the United States. In a recent address Dr. Tokaty made certain points to which we are glad to lend further emphasis by quotation:—

Dr. G. A. Tokaty.

"We belong to a progressive profession, the present rate of achievements of which is very high indeed. This does not mean, of course, that the right ways of further aero/space developments are ensured automatically; quite the opposite: it is this rapid progress itself which creates tremendous difficulties and uncertainties. Should these be allowed to be with us, aero/space science, technology, engineering and education might easily find themselves in a blind alley.

"Thus, the greatest of all the dangers we are facing today is the absence of what may be termed the aero/space technological philosophy. It is this absence which puts some governments in a difficult position and prevents them from making long-term decisions in the field; which creates an atmosphere of uncertainty in our aircraft firms and research establishments; which confuses the minds of our able but inexperienced students; which makes some aeronautical teachers, technologists and engineers seek refuge in non-aeronautical fields because, as they put it, aero/space technology has no bright future.

"Bearing this and much more in mind, I came to the conclusion that it would be in the best interests of both college education and industrial training of aeronautical students anywhere in this country to have a national congress or regional conferences with the aim of outlining the future, the great problems of aero/space science, technology, engineering and education.

"What are the main requirements of modern technological education? First and foremost, it should be short, interesting, and cover the essential points. Both college lecturers and industrial instructors should bear in mind one important thing; our branch of technology progresses so rapidly, and it becomes so complicated, that it is physically impossible to cover everything in a short time. The only possible solution of this difficult problem is, perhaps, to revise the programmes and syllabuses of college education and industrial training so as to keep them up to date.

"This is precisely what we do now in the Department of Aeronautical Engineering. It is our well considered intention to study the most up-to-date achievements and trends in aero/space technology and to design our syllabuses accordingly. VTOL and STOL vehicles, magneto-fluid mechanics, plasma physics, hypersonic aerodynamics, supersonic aircraft design, rocket dynamics, aero/space-craft structures at high temperatures, single- and multi-stage rocket design, modern propulsion systems, such are some of the new subjects which are expected to become an organic part of our Dip.Tech. aeronautical education."

Following the conference at which this address was given various resolutions were circulated, including:—

(a) College education and industrial training are organic, essential and inseparable parts of modern technological education; therefore there is a need for closer co-ordination between the college syllabuses and programmes of industrial training.

(b) There is a need to establish closer contacts between the college teachers and industrial instructors.

(c) It is felt that lists of Dip.Tech. projects should be re-examined with the aim of seeing whether they reflect the modern trends and developments in aero/space technology. In any case, they should be enriched by topics of a more technological nature. In doing this, a closer co-operation between industrial firms and colleges is needed.

(d) As Dip.Tech. is a new qualification, it is felt that the methods of examination of Dip.Tech. projects must be established as soon as possible. One of the possible methods is public defence of a project.

(e) Block release of students has undoubted advantages and should be most welcome.

H. B. Irving

WITH the death of Mr. H. B. Irving, O.B.E., on Jan. 12 in hospital at Stoke Mandeville, Bucks., British aeronautics has lost one of its least publicized figures, but all who were privileged to work with him know that it lost also one of its most enthusiastic research workers as well as a man of sterling character. Members, and particularly founder members, of the Manpowered Aircraft movement mourn a whole-hearted backer and co-ordinator of their efforts.

Henry Braid Irving was born on Apr. 25, 1889, at Hoole, near Chester. After being educated at King's School, Chester, and Manchester University he gained on the Clyde the practical and design experience in marine engineering which was to serve him in such good stead throughout a long life devoted entirely to British aeronautics after he joined the National Physical Laboratory to undertake aerodynamic research early in 1914.

In the course of his quarter-century of work at the N.P.L. he contributed substantially to the A.R.C. Reports and Memoranda on spinning and stability. First to draw attention to the use of slots in connection with control, he was awarded the Charles Wakefield Gold Medal of the R.Ae.S. in 1929 for research associated with this problem. He became a Fellow of the Society in 1932.

It is nearly 30 years ago now, but one recalls vividly the lecture he gave jointly to the R.Ae.S. with A. V. Stephens on "Spinning." A feature of the occasion was a demonstration of freely falling models in a vertical wind-tunnel set up on the dais.

His always lively interest in practical affairs may be gathered from reference to THE AEROPLANE. In May, 1936, we reported that Mr. H. B. Irving had devised a method of balancing split flaps to reduce operating loads. The drawings by J. H. Clark showed the eminent practicability of the idea.

On May 26, 1937, he wrote an article for us about a suggested means of obtaining variable wing area. The scheme was to arrange a biplane wing structure so that it might be folded together into a monoplane wing to reduce wing area. The text was accompanied by wind-tunnel results obtained from suitably devised aerofoil sections. In that article he wrote: "This process of varying the area (Zap and Fowler flaps) will probably be made to go much farther with the aid of modern hydraulic gear and mechanisms. The only alternative one can see to this is the successful development of boundary layer control, either in increasing maximum lift or (a more remote possibility) in reducing drag by keeping the boundary layer laminar."

One also recalls a proposal by Irving for a swept-forward wing biplane which had anti-spinning characteristics. This could have made it useful as an unmanned radio-controlled target machine.

In 1939 Irving was chosen to start a new experimental research station on stability and control at Duxford. To this end his long association with the N.P.L. was severed and he was transferred to the R.A.E., but the outbreak of war frustrated the intention, so he remained to do research wind-tunnel work at the R.A.F.

When hostilities ended, Irving was posted to the Ministry of Supply in London, becoming Assistant Director of Scientific Research until he retired in 1954. But he was a very energetic 65 and for the next three years he became consultant on noise to the Ministry. In 1957 he severed his official contacts with the Ministry of Supply and became consultant to Bristol Siddeley Engines, Ltd., and Westland Aircraft, Ltd. At the time of his death he was chairman of the Noise Research Committee to the Aeronautical Research Council. His efforts in this field were untiring, though many of us consider that the country has yet to deploy adequate resources to the work.

He had also become chairman of a little-known body, the Low Speed Aerodynamics Research Association, which had come into being to find out more about flight at very low speeds, as practised, for example, by insects. In this capacity he attended the historic meeting at Cranfield in January, 1957, at which MAPAC was founded, internationally known today as the Manpowered Aircraft Group of the R.Ae.S.

One of his colleagues on that committee has written:—

"Even at the age of 71 he was imbued with tremendous energy and enthusiasm, and after retirement from the Civil Service, put his active mind to the problem of noise abatement in aircraft design and in guiding the Manpower Flight Group. His spare time remaining was spent in learning to glide.

"Although quiet and unassuming he was an efficient chairman in his own characteristic way, making definite decisions with firmness and charm. He was a firm believer in the possibilities of manpowered flight and his enthusiasm inspired members of his group. With his energetic assistance every scrap of information in the design history or current activities of manpowered flight was brought to the attention of the committee.

"Irving kept up a very considerable correspondence and wrote convincing articles on this, his pet subject. The fees he obtained were promptly paid in to the R.Ae.S. in aid of manpowered flight projects. Indeed it was due to his ability in conveying the possibilities of manpowered flight in such a convincing manner that the group was eventually taken under the wing of the Royal Aeronautical Society."

Early in October last he was taken to Stoke Mandeville hospital near Aylesbury, paralysed as a result of an accident to the car in which he was a passenger. He kept his cheerfulness and courage when helpless on his back and, indeed, sent us an article which we duly published in our issue of Nov. 4. In spite of such courage he was not fated to recover and passed away in his sleep on Jan. 12.

We, who were proud to call him friend, will miss him much.—T.J.

Aviation News in General

LONDON AIRPORTS RE-NAMED—To stress the increasing interdependence of London's two major airports, they will be known from Apr. 1 as London (Heathrow) Airport and London (Gatwick) Airport.

B.37 EXPLAINED.—Moscow's reference to Soviet ships in the Red Sea being buzzed by a British B.37 bomber last week seemed to baffle the daily newspapers in this country, who were unable to find an aircraft of this type. The designation clearly referred to Shackleton "B" of No. 37 Squadron, which is based at Khormaksar, Aden and, in common with all R.A.F. maritime aircraft, wears its squadron number and aircraft identification letter on the fuselage side. Both British and American aircraft have been keeping close watch on Russian vessels engaged on radar reconnaissance and other questionable activities.

RECORDS CLAIMED.—Six 1,000-km. closed-circuit speed records with a two-tonne payload are claimed by the U.S.A.F. for its Convair B-58 supersonic bomber which on Jan. 13 averaged 1,061 m.p.h. over 1,242 miles from Edwards AFB.

DECCA IN SPACE.—A group of senior engineers is being formed by Decca Radar, Ltd., to conduct research and development in the field of space electronics. The team will shortly be transferred to a new laboratory on the company's development site at Somerton Airport, Cowes, I.o.W.

C.160 PRESSURIZATION.—Normalair has received a £40,000 contract for the design and supply of cabin air conditioning and pressurization equipment for three prototype Transall C.160 military transports.

SIKORSKY ORDER.—The U.S. Navy has placed a $34 million order with Sikorsky Aircraft for the production of HSS-2 anti-submarine helicopters. Designed mission of the HSS-2 is a four-hour patrol carrying both search gear and attack weapons.

MARCH ARRIVAL.—First of the Polaris-equipped nuclear submarines, the 5,600-ton "George Washington," is due to arrive at Holy Loch, Argyllshire, towards the end of March. The depot ship, "Proteus," is expected to berth "a few weeks earlier."

HARVARDS IN LAOS.—Hitherto a transport and communications force with about 50 light and medium-sized aircraft, the Laotion Army Aviation Service received four N.A. Harvard armed trainers last week under the U.S. military aid programme. The Harvards can be fitted with machine-guns and rocket racks, as they have been in Algeria where they are used in large numbers by the French against the rebels. The Laotian Harvards have been obtained as a counter to Soviet aircraft, including Ilyushin Il-14s, used in support of the Pathet Lao rebels.

LOADED LULU.—First photograph of the U.S. Navy's new atomic depth charge —code-named Lulu—mounted on an HSS-1 anti-submarine helicopter.

FOR BOATING ENTHUSIASTS

THE first of the new mid-monthly editions of our associate journal *The Motor Boat and Yachting* will be on sale tomorrow, Jan. 21, price 2s. The principal feature of this 148-page issue will be a comprehensive review of the International Boat Show. And in the first of a new series of articles, Francis Chichester, the Yachtsman of the Year, describes his preparations for the single-handed trans-atlantic race which he won in July, 1960.

SCOUT SUCCESS.—A U.S.A.F. Blue Scout rocket, launched from Cape Canaveral on Jan. 7, reached a height of some 1,000 miles penetrating the lower region of the Van Allen radiation belt. Results from eight experiments were telemetered to ground stations "providing valuable information."

SPRAYMAT IN GERMANY.—Westfälische Metall Industrie KG, Hueck and Co. of Lippstadt, an electrical and plastic motorcar accessory firm, is to manufacture and market the Napier Spraymat electrical de-icing system in West Germany. Full-scale production begins in May and initial quantities will be for the European-built F-10-G Starfighters. Spraymat is also to be used on the Transall C-160.

SPACE-MEN LOST?—Col. Hickman of the U.S.A.F. said on Jan. 14 that two Russians perished in an attempt to orbit a Soviet spacecraft last September while Mr. Khruschev was in New York attending the United Nations meeting.

ROCKETS FROM JAPAN.—It was recently announced in Tokyo that Japan is to export six Kappa-6 solid-propellent sounding rockets and a launcher to Yugoslavia. Arrangement has been negotiated between a Japanese trading company, Mitsui Bussan Kaisha, and the Yugoslav Rocket Society. The Kappa rocket programme was described in our issue of Oct. 7, 1960, pp. 497-499.

SPACE SHOT?—After three Soviet missile monitoring ships, the "Sibir," "Chukhotka," and "Sakhalin" had been reported steaming towards an area 1,000 miles south-west of the Hawaiian Islands, the U.S. Defense Department stated that on Jan. 14 a radar station off Alaska had tracked a rocket launched from Russia which appeared to be destined for a target centre in the Pacific Ocean.

Commercial Aviation Affairs

MORE COMETS.—United Arab Airlines has increased its order for Comet 4Cs from three to five, the two new aircraft to be delivered this summer. The total of Comet 4 series now ordered is 62, including 17 Comet 4Cs.

MEXICAN AGREEMENT.—At the end of December, Mexicana and Guest Aerovias announced an agreement (subject to Government approval) to join forces on international routes, on which four Comet 4Cs will be shared. Mexicana has three Comets at present and a fourth will presumably be ordered in due course. The agreement covers co-ordination of maintenance, training, sales and publicity programmes. The first Comet service in Guest colours is expected to operate at the end of this month.

JERSEY HERALDS.—Jersey Airlines hopes to have its first Herald 200 in service in time for an inaugural Hurn-Jersey service on May 19. The first Gatwick-Jersey service will be flown on May 20 and the first from Jersey to Paris on Jly. 24.

LONG NON-STOP.—El Al plans to introduce a non-stop service from Tel Aviv to New York with its Boeing 707s for delivery later this year. The great circle distance of 5,666 statute miles is claimed to make this the longest scheduled non-stop service in the World. By comparison the London-Los Angeles distance, over which Pan American recently completed the first commercial non-stop flight by Boeing 707, is 5,443 statute miles. El Al's four Britannias recently completed three years in service between Israel and New York.

B.E.A. BRITANNIA.—To help overcome a capacity shortage this summer, attributable in part to the need to continue training on the Vanguard, B.E.A. is seeking to charter a Britannia 102 from B.O.A.C. for three round trips a day between London and Paris in June and four a day in July and August. B.E.A. is committed to considerably expanded domestic operations this summer and will also be opening new routes to Budapest, Oporto and Palermo.

UNITED TRAINING.—United Air Lines has concluded an agreement with S.A.S. for the training of a group of pilots on the Caravelle simulator in Stockholm. A party of instructors will arrive in Sweden on Jan. 21 and will be followed by a further group of 33 pilots in March.

A.T.L.B. HEARINGS.—No date has yet been fixed for the first hearing by the A.T.L.B. It is likely to be held at the temporary premises at 3 Dean's Yard, Westminster, S.W.1. Hearings will eventually be held at the permanent offices in Therese House, 29-30 Glasshouse Yard, E.C.1, which the secretariat hopes to occupy by March of this year. For more news of the A.T.L.B. see p. 61.

CRACK SURVEY.—Two of the four C.A.A. Viscounts recently withdrawn from service (see our previous issue) resumed operations on Jan. 12. Work on the other two, in which cracks were discovered in the spar boom end fittings, is continuing and they are expected back in service shortly. While the Viscounts were grounded, Royal Rhodesian Air Force Argonauts were used to maintain C.A.A. services and only one flight was cancelled. B.E.A. was still inspecting its Viscount 702s this week and a few domestic services were cancelled.

MANCHESTER EXTENSION.—Plans for a 3,500 ft. extension to the south-west of the main runway at Manchester Airport have been agreed by the Airport Committee. The extension, which is in addition to 500 ft. at the north-east end already approved (our issue for Dec. 16, p. 794), will cost £3½m. and will involve construction of a tunnel for the Altrincham-Wilmslow road and a culvert for the River Bollin.

DELTA TOES THE LINE.—Since the Port of New York Authority filed a suit against Delta Air Lines for failure to comply with the anti-noise regulations at New York International, the airline has had a "virtually perfect record." Five violations were recorded in 263 take-offs, compared with 220 violations in 841 take-offs between January and September, 1960. The lawsuit has been withdrawn.

1960 TRAFFIC.—Provisional M.o.A. statistics for United Kingdom airlines show a 23% increase in revenue short-ton miles in 1960 over 1959. Capacity short-ton miles offered increased by 25% and the overall load factor went down from 62% to 61%.

IRISH RECORD.—During 1960 Irish International Airlines carried a record 715,000 passengers, including 681,000 on European routes—a 23% increase. The transatlantic passenger traffic increased by 46%, and cargo and mail by just over 50%.

ITALIAN CHARTERS.—Alitalia has now set up its associated charter company with the name Societa Aerea Mediterranean. The fleet comprises two 80-seat DC-6Bs.

FLYING ENTERPRISE.—The Danish charter company Flying Enterprise which began operations in January, 1960, completed 436 flights during the year with three Canadair Argonauts purchased from Overseas Aviation. More than 45,000 passengers were carried. Another Argonaut will be added to the fleet in March.

IATA FACILITATION.—The next meeting of the IATA Facilitation Advisory Group will be held in Tokyo on Jan. 24. The chairman will be Solve Haegerstrom of S.A.S. and the meeting will pay special attention to air freight.

GATCO MOVE.—The Guild of Air Traffic Control Officers has now changed its London address to 14 South Street, Park Lane, W.1. Guild business will continue to be dealt with, however, from the old address of 118 Mount Street, W.1, until further notice.

ACCIDENT REPORT.—An official commission investigating the crash of a Finnair DC-3 on Jan. 3 is reported to have said that both the pilot and the co-pilot were under the influence of alcohol at the time. No evidence of mechanical or other failure in the aircraft was discovered.

DOMODEDOVO.—The finger-and-gate layout at Moscow's new international airport at Domodedovo (see our issue for Dec. 16, page 796) is shown in this picture of a model. It is expected to be open to traffic this year.

News About People

FSF APPOINTMENT. — Dr. Theodore P. Wright, a former Civil Aeronautics administrator and retiring vice-president for research at Cornell University, has been appointed president of the Flight Safety Foundation. Mr. Jerome Lederer continues as the foundation's managing director.

B.U.A. APPOINTMENT.—Capt. E. N. Jennings, D.F.C., who was awarded an M.B.E. in the New Year's Honours list, has been appointed general manager, flight operations, for British United Airways.

IATA OFFICERS. — Mr. Douglas Newham of B.O.A.C. and Mr. Harold Ferris, T.C.A., have been appointed chairman and vice-chairman respectively of the North Atlantic Technical Panel of IATA. New chairman and vice-chairman of the European-Mediterranean Technical Panel are Capt. Gordon McGillivray, M.E.A., and Mr. Lars Enderlein, S.A.S.

D.H. EXECUTIVE.—Responsibility for all research and development work at the de Havilland Aircraft Co., Ltd.'s Manor Road factory, which is engaged in the design of air-to-air missiles, propellers, fuel controls and other aircraft equipment, has been given to Dr. G. H. Hough. He has been appointed chief executive (engineering).

WESTLAND DIRECTOR.—The Hon. H. N. Morgan-Grenville has resigned from the board of Westland Aircraft, Ltd., on his retirement from business.

DOWTY DIRECTOR. — Service manager since 1944, Mr. W. Spires has now been made a director of Dowty Rotol, Ltd.

EKCO-PYE APPOINTMENTS.—Following the Ekco-Pye merger, Mr. N. A. Twemlow, director of Pye, Ltd., has been appointed to the board of E. K. Cole, Ltd., and Mr. W. M. York, commercial director of E. K. Cole, Ltd., becomes a director of Pye, Ltd.

SAFETY ADVISER.—Air Marshal Sir Charles Guest has been appointed adviser on flight safety to B.O.A.C. and will act as chairman of its Air Safety Committee. He was chief aeronautical adviser (Civil Aviation) to the Minister of Aviation until the end of last year.

Air Transport

The Air Operator's Certificate

AFTER Mar. 30 next, British operators of aircraft of more than 5,000 lb. gross weight which are used for public transport must be in possession of an Air Operator's Certificate (A.O.C.). Under the terms of the Civil Aviation (Licensing) Act, 1960, this document is "a certificate of the operator's competence to secure that aircraft operated by him . . . are operated safely."

Details of the procedure to be followed in issuing these certificates have now been circulated by the Ministry, and make it quite clear that a close control is to be exercised in future on the operations of British airlines. The 5,000-lb. weight limit ensures that this control extends down to small taxi and charter companies which might not otherwise be regarded as "airlines." Public transport, as defined in the Act and in the Air Navigation Order, 1960, includes the carriage of passengers or cargo for hire or reward, or gratuitously if not in the employment of the operator of the flight in question.

Before an A.O.C. is issued, inspections will be made by:

(a) A member of the M.o.A. Flight Operations Inspectorate, in respect of operating standards, organization and facilities.

(b) An M.o.A. training inspector in respect of the general adequacy of training arrangements and of periodical tests for all flight crews; and

(c) An A.R.B. surveyor in respect of the adequacy of the organization, facilities and arrangements for aircraft maintenance at home and overseas.

These inspections will involve detailed examination of all aspects of aircraft operation, including the navigational equipment provided, and may take "several days to complete depending on the complexity and size of a company's organization." The certificate—issued by the Director of Aviation Safety and Licensing at the Ministry—will be awarded only upon satisfactory reports being received from all three inspectors, including reports on flights made by inspectors in the operator's aircraft in the course of normal operations.

The standard of competence which the inspectors will expect is broadly laid down in the Air Navigation Order, 1960, and particularly in the Tenth Schedule thereto detailing the operational requirements for public transport with reference to the provision of operations manuals, crew training and testing.

When applying for an A.O.C., operators must provide a list of managerial and key executive staff (e.g. managing director, chief pilot, operations manager, traffic manager, check captain, training captain, etc.). These will be listed in each A.O.C. and any changes in personnel or their responsibilities must be notified at once to the M.o.A. The Director of Aviation Safety may also concern himself with staffing in general if it "does not appear to be commensurate with the type and extent of the operations undertaken" and the extensive use of free-lance flying personnel will not normally be acceptable.

A typical A.O.C. will cover a specific operator for one or more types of aircraft, but special conditions may apply to the use of specific aircraft types, and the regions in which each type is permitted to operate will also be specified. Provision is made for designating nine regions, from "England, Scotland and Wales" as a minimum to the whole World as a maximum. The intermediate stages each include the U.K. and progressively more territories overseas.

Fiumicino Opens

TO the great relief of all concerned, all the airline companies operating through Rome have now agreed to move from Ciampino to the new airport at Fiumicino as soon as possible (see our previous issue). The change-over will take place in two stages. First to move are all the companies at present operating from the west side of Ciampino, which include Alitalia, P.A.A., T.W.A., S.A.S., Sabena, Lufthansa and others. These companies moved on Jan. 16, the same date as that originally independently announced by Alitalia.

A week later, at midnight on January 22/23, those companies operating on the east side of Ciampino will move to Fiumicino. These include B.O.A.C., B.E.A., S.A.A., Qantas, K.L.M. and Air France.

An official communiqué to this effect was published following a meeting between the Airline Operators' Committee and General Santini, Director General of Civil Aviation. At this meeting, the AOC informed General Santini of the findings of the four sub-committees which they had appointed to examine various aspects of the readiness of Fiumicino for full-scale operations. All four sub-committees had reported favourably and the airline operators were unanimous in wishing to complete the move to Fiumicino as soon as possible.

Although the actual opening of Fiumicino will do much to halt the public criticism of this project, Fiumicino's troubles are not yet over. Indeed, in one sense, they are only just starting. It has yet to be decided, for instance, who is to be given the responsibility for the management of the new airport. Informed opinion, however, predicts the imminent formation of a new private company to run Fiumicino, in which Alitalia will be the major shareholder.

One of the major drawbacks of the new airport has become immediately evident with the announcement by airline companies of the new times for passengers to report to the city terminals. Alitalia, for instance, has announced that for intercontinental flights passengers will be required to report to the city terminal 2 hours 30 minutes before time of take-off and for international flights 2 hours 15 minutes.—T.D.C.

Tape Testimony

THE great value of flight recorders has now been shown in the investigation into the New York collision. Although it could be inferred from other evidence that the DC-8 had overshot the Preston holding pattern, the tape record from its flight recorder has positively confirmed the fact. Meanwhile, the F.A.A. has asked for the tapes from recorders in about 40 other turbojet aircraft, which used the Preston pattern prior to the collision, in order to check pilots' operating practices.

The recording showed that the United DC-8 was at 8,700 ft. as it passed the Preston intersection and that its ground speed, with a 33-knot tail wind, was more than 435 knots. When the collision occurred the speed had been reduced to 315 knots and the altitude was about 5,200 ft.

During the seven-day inquiry in Brooklyn the La Guardia controller who (see the transcript quoted in "A.T.C. in the Raw" on p. 62) had twice warned the T.W.A. L-1049 of approaching traffic, explained that controllers were not instructed to give heading changes except at a pilot's request. With a two-dimensional display, a collision-course echo is obviously not of itself a cause for alarm.

At the inquiry United has been seeking to show that a VOR (Colt's Neck) used for fixing at Preston might have been faulty. The evidence has been mixed; four airline captains testified that they experienced trouble and three reported no difficulties.

AT LAST.—T.W.A. began operating Convair 880s on Jan. 12 following successful conclusion of the financing deal by Howard Hughes. Four Convairs in T.W.A. colours are shown, below, ready for delivery at San Diego.

Spot not on the map

You are unlikely to find Jiwani in your atlas. A small fishing village, it lies in rugged, waterless country on the coast of West Pakistan, 40 miles from the Iranian border and 350 air miles from Karachi. Roads are mere sand tracks and the only approach is by sea or air.

Air? Yes, Jiwani has an airfield. True, today's airliners seldom use it, except in emergency; but to smaller aircraft of limited range flying through to the Far East it is an essential staging point.

Life at the base is lonely and spartan. Water is rationed and food is sparse. Communications are poor. There is an irregular coastal launch service from Karachi and once a month a Dakota of Pakistan International Airlines flies in supplies and relief staff. Mail comes via Gwadur 65 miles away by runner or camel. How welcome are the visitors who land to fuel!

To keep Jiwani supplied with aviation fuel is far from easy. But Burmah-Shell takes care of that. Supplies are shipped from Karachi in "country craft" which are run aground at high tide and the drums off-loaded by plank ramps to the shore. The trip takes 8-10 days, but for 4 months the monsoon makes sailing well nigh impossible.

Shell aviation service operates in all kinds of places throughout the world, no matter how difficult they may be to supply . . . at famous international airports and at little-known airfields which, like Jiwani, serve Aviation in remote parts.

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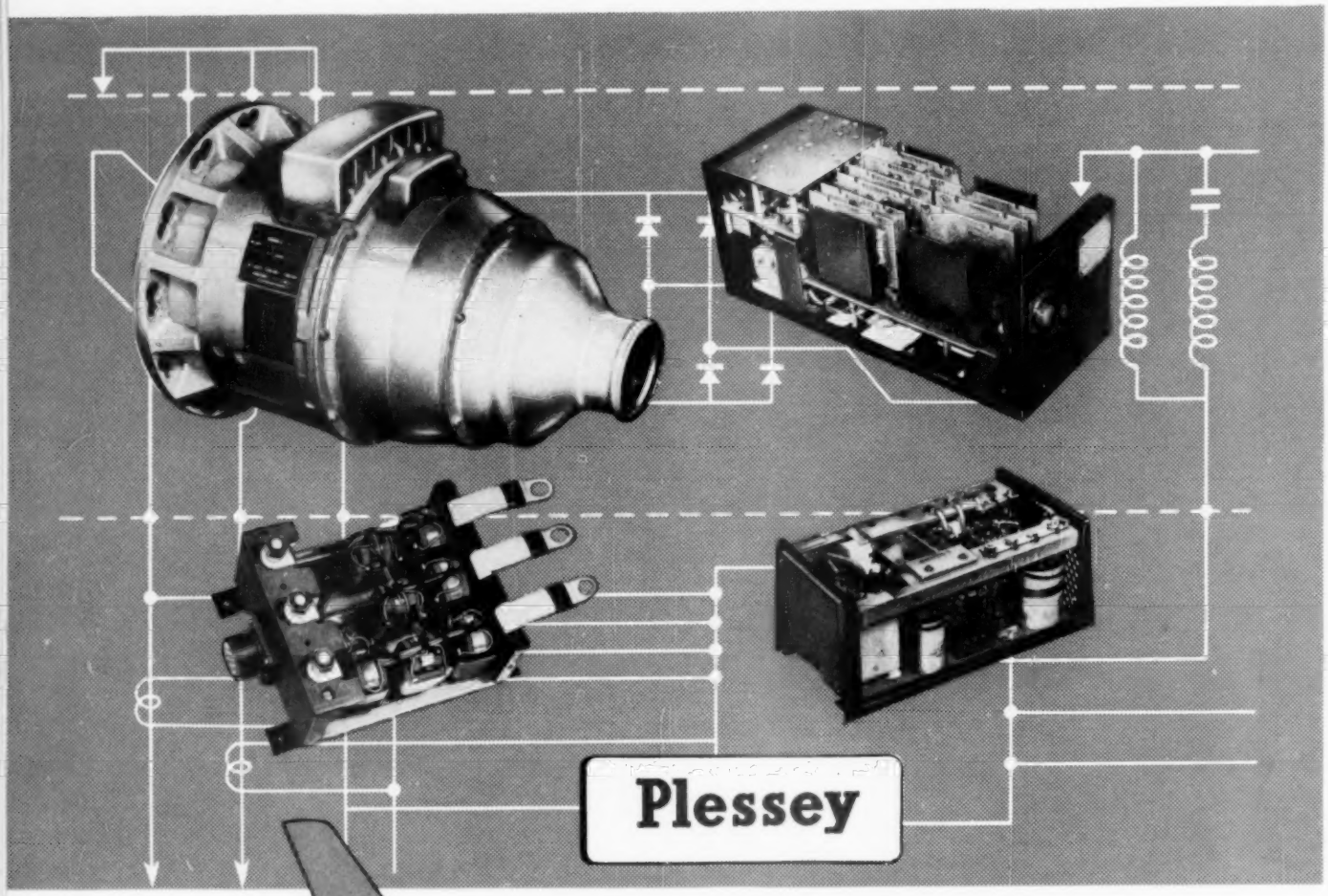

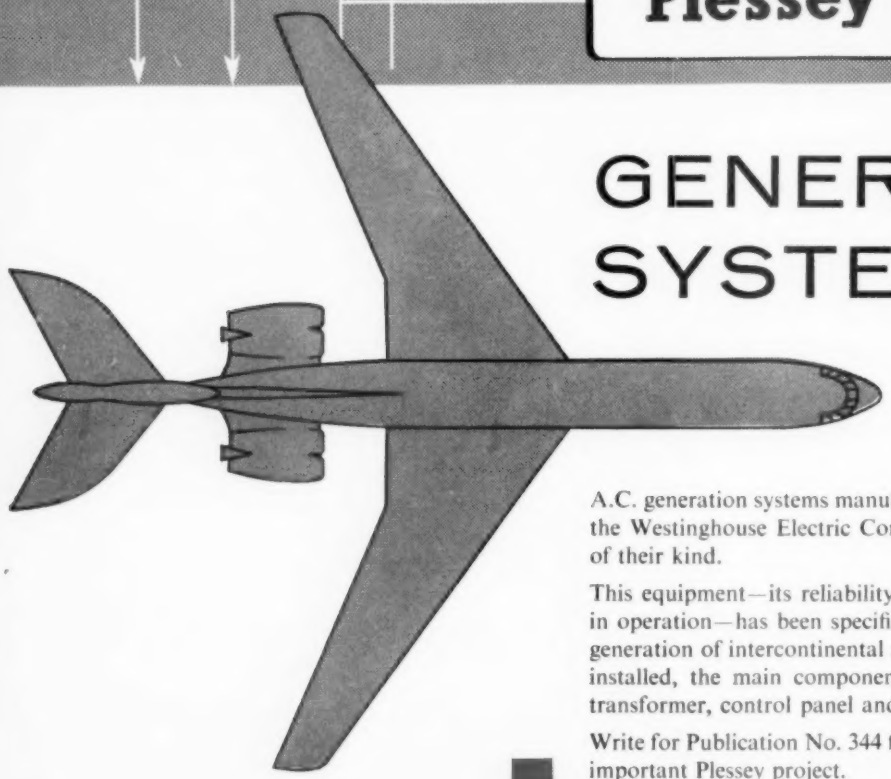

GENERATION SYSTEMS

A.C. generation systems manufactured by Plessey under agreement with the Westinghouse Electric Corporation, USA, are the most advanced of their kind.

This equipment—its reliability and all-round advantages fully proven in operation—has been specified for the Vickers VC 10, BOAC's next generation of intercontinental airliners. Four 40 kVA channels will be installed, the main components of each channel being a generator, transformer, control panel and voltage regulator.

Write for Publication No. 344 for more information about this new and important Plessey project.

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Air Transport . . . .

The Board and British United

AN unpretentious but in its way historic document appeared on Jan. 11—the first issue of the Air Transport Licensing Board's *Civil Aviation Licensing Notices*. In future, these Notices will be the sole means of making public the details of: applications to the Board for air service licences; public hearings; Board decisions; and other relevant matters. The practice of the Air Transport Advisory Council of advertising applications in selected daily newspapers and the weekly aviation journals will be discontinued.

Licensing Notices No. 1 comprises nine foolscap pages of duplicated typescript, of which the first four pages are permanent notes about the issue of the Notices and procedures for making applications for air service licences, attending hearings, obtaining transcripts and appealing to the Minister. The remainder of this issue is taken up with details of the applications from British United Airways for a series of services from Gatwick to destinations in the U.K., Europe and Africa (see our issue for Jan. 6, p. 8).

As we then explained, these proposed services fall into three categories. First there are 17 scheduled, multi-class passenger, freight and mail services forming an integrated pattern to European and domestic terminals. These, and a second series of integrated seasonal mixed-class services for holidaymakers to 13 European destinations, would be flown, says the application, "with Viscount (Mks. 736, 804, 831, or 833) aircraft and later with Trident aircraft or other modern types as they become available."

The third group of three scheduled multi-class services, to destinations in Africa, would be flown "with Britannia aircraft and later with Vickers VC10 aircraft." Frequencies specified in the applications range from twice-daily on some European routes to once-weekly on the African services, with the proviso that they could be increased later in accordance with traffic demand. Licences for an indefinite period are requested in each case. Except on the domestic services, tariffs would be in accordance with IATA "or as may be approved by the Minister of Aviation from time to time." Tariffs proposed on the domestic routes to Manchester, Glasgow, Edinburgh and Belfast are comparable with B.E.A. fares, but generally a few shillings higher because of the greater flying distances involved.

As we said when first reporting these applications, B.U.A. has provided the A.T.L.B. with a test case—for which the airline was apparently willing to pay £3,100 in non-returnable application fees. The size of the test begins to become apparent when the applications are studied in detail.

With the exception of the four domestic services, each of the 33 routes requested by B.U.A. is to a foreign destination. Approval for B.U.A. to operate such services therefore depends not only on the issue of appropriate air service licences but also on obtaining the approval of the foreign Governments concerned. All the terminals specified by B.U.A. in the first and third groups are already served by B.E.A. or B.O.A.C.; one would not be surprised, therefore, to find most foreign Governments saying—if asked—that any B.U.A. service should be regarded as part of the total British share of traffic already agreed. Would it then represent "material diversion" from the B.E.A. or B.O.A.C. services—or can the A.T.L.B. and Minister be convinced that traffic on these routes justifies multiple designation?

It is by no means certain, of course, that any foreign Government will be asked to accept any of these B.U.A. services at all. Clause 2, subsection (3) of the Civil Aviation (Licensing) Act, 1960, requires the Board to refuse an application "if . . . the Minister so directs in writing on the ground that any air transport service proposed in the application would in his opinion involve the negotiation with the Government of some other country or territory of rights which it would be inexpedient for the time being to seek." Will the Minister think it "inexpedient" to ask for permission for these B.U.A. services? Could the inclusion of the Trident and VC10 as possible future equipment in the B.U.A. application be interpreted as a promise to buy British equipment if the Minister blesses the application? If so, how will the Minister balance this prospect of sorely needed new business against the protests of B.E.A. and B.O.A.C. over loss of traffic?

If the applications are allowed to reach the stage of a full Board hearing, they will be considered by the following: Prof. R. G. D. Allen, professor of statistics at the University of London; Mr. C. Bagnall, managing director of British Nylon Spinners, Ltd.; Mr. E. Baldry, a chartered accountant; Sir Friston How, a professional civil servant and secretary of the Atomic Energy Office until his retirement in 1959; Mr. W. P. James, chairman of the West Midland Traffic Area since 1952; and Mr. A. H. Wilson, adviser on commercial air transport to the Ministry and assessor with the A.T.A.C. With the much-regretted decease of Lord Terrington, the post of chairman is at present vacant.

With its almost complete lack of aviation expertise (excepting that of Mr. A. H. Wilson) this Board is presumably expected to act in a judicial capacity after listening to arguments for and against a particular application. The burden on the small secretariat for the A.T.L.B. is therefore going to be a particularly onerous one. Constituted and briefed as it is, the Board might be forgiven for hoping that the Minister will in this case exercise his option under Clause 2 (3)—but it will be an unhappy augury for British civil aviation's "new look" if this first real issue is not put to the test at all.

Subsidies for the Local Airlines

A FEATURE of post-World War II air transport in the U.S.A. has been the large Government subsidy paid to the local service airlines. Although the dependence of these airlines on subsidy has steadily decreased—only 32% of their total revenues in 1959 came from the Government, compared with about 75% when operations began—the actual amount of subsidy paid has been increasing with the growth of local service operations, and in 1960 was over $50 million.

The Civil Aeronautics Board, which is the Government agency responsible for administering these subsidies, has now proposed an entirely new basis for calculating the amount received by each of the 13 local service airlines.

Hitherto, subsidies have been calculated to allow each airline to meet its total costs plus a small return on investment (about 5%). Airline managements have thus had little incentive to cut costs and improve efficiency, as this merely led to a reduction in subsidy. The new formula proposed by the C.A.B. would provide a fixed subsidy per available seat-mile offered by the airlines, and would allow a rate of return on investment of at least 10% to be made. If the rate of return exceeded the agreed average, an appropriate amount of subsidy would be withheld.

The "class rate" formula worked out by the C.A.B. will give the local operators about the same amount of subsidy in 1961 as they received in 1960, but the new basis of calculation leaves room for airline efficiency to be rewarded. Four different mileage rates are proposed, according to the average daily mileage flown per city served, ranging from 3.05 cents per available seat-mile below a 300-mile average distance to 1.9 cents for over 600 miles. The subsidies will be calculated monthly.

Last year, the 13 local service airlines were serving about 560 cities and towns, of which more than 300 were served only by these airlines. In order to place the local carriers on a sounder financial basis, the C.A.B. is, however, to allow them to cease service at points which provide fewer than five passengers a day, and to serve more major traffic points at present reserved for the trunk operators. By these and other means, it is hoped to put the local carriers on a non-subsidy basis by 1970.

North Atlantic Boom Continues

FIGURES issued by IATA for the third quarter of 1960—though incomplete and set out, this time, only in a discursive form and without the usual tabulation—show continued substantial increases of scheduled North Atlantic traffic carried by Association members.

During July, August and September the number of scheduled service passengers in both directions totalled 670,124—an increase of more than 28% on the total (523,031) for the same three months of 1959. Cargo and mail traffic increases were even more spectacular, with jumps of more than 42% and 44%—to 25,722,941 lb. (12,861 short tons) and 8,853,686 lb. (4,427 short tons) respectively.

The passenger load factor dropped in relation to the 1959 figure—as might have been expected with the increase in the number of seats offered by the enlarged turbojet fleets—but was still very high at 68.7%.

In the first three quarters of 1960 a total of 1,376,902 passengers were carried on scheduled North Atlantic services. Assuming no more than a 15% increase in the fourth quarter, the total for 1960 will be about 1,700,000. With the steady increase in non-scheduled operations, it may be guessed that the total North Atlantic passenger traffic for 1960 will top the two million mark. Last year's sea passenger total was about 850,000.

D

Air Transport . . . .

AUSSIE HELICAB.—Following the opening of a heliport on the River Yarra in Melbourne, both T.A.A. and Ansett-A.N.A. are offering helicopter services from Essendon Airport to the city centre. The heliport is 40 ft. square, supported by two pontoons. All fuelling for the helicopters is at Essendon, where this T.A.A. Bell 47 was photographed.

The Air-freight Business

THE announcement of the development in the U.S.A. of a military/civil turbofan all-cargo transport (see last week's issue, p. 33) leads to the inevitable question: just how costly will be the compromise for the prospective civil operators?

However good the F.A.A./U.S.A.F. co-operation may be, it is impossible to imagine, for instance, that the performance requirements can be similar. Differences here are likely to be more prospectively costly to the civil operator than those concerned with physical features—which may involve no more than relatively superficial compromises. The military requirements must obviously take priority.

In fact, all high-speed aircraft are inevitably compromised, when considered as freighters, by the simple fact that the fuselage must be circular, or nearly circular, in section. Since a floor must be arranged somewhere across this section, the fuselage is therefore divided longitudinally into two most inconveniently shaped holds or series of holds.

In a paper delivered last week in Detroit, Canadair's co-ordinator of cargo systems, Mr. Joseph A. Morley, made no bones about the losses of useable volume caused by these awkward shapes and by the use of mechanized loading systems—but showed how some of the theoretical losses could be reduced and higher load factors maintained. In simplest terms, the freight is loaded according to its relative density so that the best use is made of the available volume and load-carrying capacities of different parts of the fuselage.

Allowing for space losses, the minimum average "warehouse density" of loads accommodated by the CL-44 is 12.5 lb./cu. ft.; for overall densities below this figure the aircraft is space limited. But the actual cargo items may vary in their individual densities between, say, 5 lb./cu. ft. and 30 lb./cu. ft. So it is sometimes useful to have cargo areas which are limited in terms of weight or volume.

In the CL-44 the forward cargo compartment is volume limited, but can take an 8,000 lb. load; it is thus most efficiently used for high-density items up to an average of about 30 lb./cu. ft. At the other extreme the compartment in the swing tail is load-limited (to 3,000 lb.), but is relatively roomy, and would therefore be packed with low-density cargo.

Mr. Morley mentioned a new analytical technique for establishing achievable load factors. This uses the probability of the expected payload and density distributions to forecast the average achieved payload or load factor for a specific operation.

A.T.C. in the Raw

THE 90-page transcript of A.T.C. conversation, which was issued publicly by the Federal Aviation Agency soon after the New York disaster, is likely to have a value beyond that which is immediately obvious.

Anyone who is prepared to apply the few hours of work involved in its reading, suitable chronological rearrangement and re-reading will find that it tells a tale which probably no other such transcript has yet told. Specialists in the human side of air traffic control development will, after studying it, be able to put their fingers on a score of possible weaknesses in present procedural A.T.C. methods—whilst gaining a renewed admiration for the work of the controllers themselves in their near-impossible environment.

Let us look first at the simple facts. During a critical 17 minutes the approach controllers at La Guardia and Idlewild were giving successive instructions to 10 arriving aircraft—eight of them on scheduled services and two executive or non-carrier aircraft. Even whilst trying, again and again, to regain contact with the two aircraft after the collision they were coming back to deal with the remainder of the aircraft which were still airborne. The whole thing was being done "off the cuff." Is it remarkable that, even before the emergency became obvious, momentary slips of memory can be detected?

This is a small part of the transcript of the recordings (excluding replies from the aircraft) in the few minutes immediately before the disaster. La Guardia Approach Control is talking to its flock—including T.W.A.'s Flight 266:—

". . . And Trans World two sixty six the . . . glide path is out of service . . . localizer is in operation . . . continue your descent to eight thousand, expect additional descent clearance, advise leaving nine . . . Capital one thirty two . . . maintain present heading for a radar vector to the final approach course, and reduce to approach speed . . . Trans World two sixty six descend to six thousand, advise leaving eight . . . Trans World three seventy four the wind northwest at one five, turn left three three zero . . . Trans World two sixty six . . . maintain course. . . .

"Trans World three seventy four, what is your altitude, sir? . . . Roger . . . cleared for ILS approach. Turn right zero one zero, intercept final approach course on that heading. Take over and complete the approach. You're six miles behind traffic . . . cross Dodger [reporting point] at two thousand five hundred or below . . . Capital one thirty two turn further right, er, one four zero for a radar vector to the final approach course. . . .

"Trans World two sixty six reduce to approach speed, please . . . Capital one thirty two, continue your descent to one thousand five hundred . . . you're cleared for ILS approach, turn left zero six zero, intercept final approach . . . your present position is 10 miles southwest . . . Trans World two sixty six, turn right one three zero . . . continue descent to five . . . make that further right one five zero. . . .

". . . and Trans World two sixty six, traffic at two thirty, six miles northeastbound . . . Trans World three seventy four contact La Guardia Tower now, one eighteen seven, that's Runway Four, sir . . . Trans World two sixty six, what is your altitude? . . . Fifty five hundred, is that correct? . . . Roger, continue your descent to one thousand five hundred . . . and turn left now heading one three zero . . . Roger, that appears to be jet traffic off your right now three o'clock at one mile northeastbound. . . ."

Afterwards, whilst still dealing with "Capital one thirty two," with Douglas "Nan seven four Charlie" and an anonymous "Nan three three Fox" (note the use of the old phonetic alphabet), La Guardia Approach Control tried 10 times to raise T.W.A.'s L-1049 Flight 266.

Meanwhile the United DC-8, after being progressed with the L-1049 by the New York Air Route Traffic Control Center, was given (at 15.33:15 hrs. G.M.T.) an improved slant visibility figure for Idlewild, was cleared down to 5,000 ft. and told to hold at the Preston stack; the N.Y. Center then said "good day." Between 15.33:28 and 15.33:54 the DC-8 spoke to and was answered by Idlewild Approach Control. Afterwards, from 15.34:17, Approach Control made 17 attempts to raise the DC-8.

A minor point which will be noticed by the specialists is that Approach Control was still giving half-a-mile visibility at Idlewild 10 minutes after Air Route Control had given the DC-8 a revised figure of 5,500 ft., or better than a mile.

Another feature which the transcript helps to make clear is the way in which, with so much traffic airborne in instrument conditions, the controllers afterwards managed to reorganize everything. Whilst the situation over the L-1049 and DC-8 was still obscure they had to keep the other traffic airborne and reallocate holding altitudes so that the 5,000-5,500 ft. level—at which the missing aircraft had last reported—could be kept clear. One of the aircraft, which had actually been on final approach into Idlewild and was told to hold over the Scotland NDB, reported that it had fuel for no more than 20 minutes' holding.

Sadly interesting, too, was the garbled nature of the first crash reports which came in to the New York Center, so that, for a while, it seemed that the DC-8 (first described as a "Navy aircraft") had crashed on Staten Island and the L-1049 (later stated to be a 707) in Brooklyn.—H.A.T.

Survey in Laos

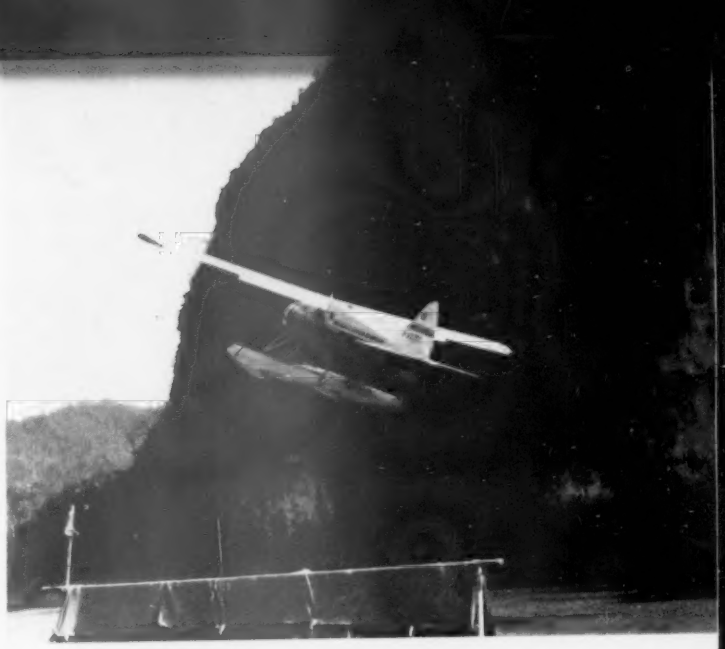
By John Skinner

LAOS is in the news. The border between that country and Thailand (which used to be known as Siam) is formed by the Mekong River. Seventh largest by volume in the World, the Mekong River is perhaps the least known. Rising in Tibet, it flows through China and Burma, before emerging as the border line between Laos and Thailand. Flowing approximately south-east, it enters Cambodia and eventually runs into the South China Sea through Viet Nam.

At the moment the river is almost completely undeveloped. It has a large hydro-electric potential in its tributaries and on the main stem, which would, if utilized, raise the living standards of the populations of Cambodia, Laos, South Viet Nam and Thailand. Other benefits would arise from irrigation projects, flood control, and improved navigation for the river boats.

The United Nations Economic Commission for Asia and the Far East conceived the idea of an international development project, covering the Lower Mekong River. As part of this project the Federal Government of Canada agreed to finance under the Canadian Colombo Plan a $1,300,000 survey and mapping programme. In addition an agreement was signed with the four riparian countries of Laos, Thailand, Cambodia and Viet Nam, whereby these countries would contribute $25,000 each towards the cost of the project.

How does one go about organizing a ground and air survey of this magnitude? Canada for many years has been a World leader in the air survey business, so the Government of Canada invited the principal air survey companies to participate; a unique experience in co-operation. Hunting Survey Corporation, Ltd. (formerly The Photographic Survey Corporation, Ltd.), of Toronto were appointed as project managers, with the following companies participating: Aero Surveys, Ltd., Vancouver; Canadian Aero Service, Ltd., Ottawa; McElhanney Nelson Air Surveys, Ltd., Vancouver; La Compagnie Photo-Air Laurentides, Quebec City; Paul Pelletier, P.Eng., Montreal; and Spartan Air Services, Ltd., Ottawa.



The amphibious Beaver climbing away from the Mekong.

Below, L. to R., Beaver on wheels at airport. Mr. Richmond of Party B checks stores unloaded from the Beaver; note the bamboo raft. Beaver afloat.

We organized seven field parties to work in Laos and Thailand, and subcontracted the work in Cambodia and South Viet Nam to a company which had had several years of experience working in this difficult area. Five of the parties were to do levelling, and the other two distance measuring with tellurometers. All of the parties were water-borne, with the exception of one that had Land-Rovers.

From previous experience on other overseas expeditions we realized that first-class communication was essential between the field parties and headquarters. We therefore ordered a two-way radio-telephone system which was easily transportable, the Racal TR55 made in England. A single sideband crystal controlled set with four channels. These sets worked extremely well during the whole expedition.

As the majority of the parties were to work on the river far away from roads, their only access to headquarters would be by water or air. River transport was slow and non-existent during the low-water period, aerodromes were few and not well maintained, so the obvious answer was an amphibious aircraft. After a discussion on the relative merits of a de Havilland

Otter versus the Beaver, we plumped for the Beaver as average resupply flights to the parties would never exceed 800 lb.

We were extremely fortunate in finding a brand new Beaver available for day lease in Pnomh Penh, Cambodia. This aircraft had had an odd history. Ordered originally for the Prince of Cambodia as an executive model, it met with a slight mishap in Singapore when a large tractor was dropped on its crate during transhipment. The underwriters sent it to Hong Kong where it was repaired by Hong Kong Aircraft Engineering. When the Prince was notified of the accident, he refused to accept the machine and wanted a new one. This was obtained, leaving the other for our use. A 45-gallon tank was fitted in the cabin and a French pilot and navigator flew it non-stop from Hong Kong to Pnomh Penh in eight hours.

Our pilot was Don Stewart, an experienced Canadian bush pilot who for years had been flying charter planes in the Arctic. As the Beaver was on wheels we had to buy a set of amphibious floats and ship them to Bangkok, where they were speedily fitted to the aircraft by Thai Airways at Don Muang airport under Don's supervision.

I had arrived in Bangkok at the end of August and had organized the gathering of equipment which had been sent from many parts of the World—canned food, tents, boats, survey equipment, fuel, drugs and last but not least, beer and cigarettes. All these supplies had to be dispatched upcountry and located at suitable points for collection by the parties.

At the beginning of November we were all set to go. The surveyors arrived slightly broke after spending sprees in Hong Kong, and without giving them time to draw breath, the Beaver flew them out to their camps along the river.

The main purpose of the Beaver was resupply of the field parties, and it turned out to be ideal for the purpose. Veha Akat, a French Laotian Aviation Co. at Wattay Airport near Vientiane where our Beaver was based, supplied the maintenance services. They themselves operated several Beavers on scheduled services in Laos, and with the help of French engineers and local technicians they provided a really excellent maintenance service at a most reasonable price.

Requests for food and supplies were sent in daily by radio and then dispatched by Beaver as soon as the urgency of the requirements dictated. Most of the parties were visited once every 10 days, sometimes more often. An early morning scene at the airport would show baskets of fresh fruit from the local market, with the odd fish tail sticking out from amongst the pineapples and bananas, repaired outboard motors, crates of beer and tins of food being hefted up onto the floats and thence into the cabin.

As summer approached this became hot work with temperatures seldom dropping below 80°, and often they were over 100° F. Don's flights were seldom longer than three hours to the farthest camps, and after a few days he was thoroughly conversant with the river. We laid in a stock of aviation fuel at Luang Prabang in the north and at Pakse in the south which were used occasionally. Over the whole expedition about 360 hr. were flown.

The immediate availability of the Beaver was a great boost to the morale of the field crews. They knew that should they fall sick, the aircraft could evacuate them within hours.

The problems involved in operating an amphibious aircraft in uncharted waters were not nearly as great as we had anticipated. Bob Brocklebank on a preliminary reconnaissance had been told fantastic tales about river conditions. Giant whirlpools, crocodiles, and large floating teak logs, all factors which would tend to make an amphibious operation rather difficult if not impossible. These stories made good telling around a bar, but were in fact without foundation. One party did see a solitary crocodile about 9 ft. long, and it is difficult to say who got the bigger fright, as they never saw it again.

Don Stewart's main difficulty was the swift current in the narrower portions of the river. This current together with strong winds made navigation and manœuvring to the mooring rafts extremely tricky. He continually had to start and stop the engine to obtain steerage way, yet not move too fast in case the momentum would damage the floats and raft on mooring.

The ground crews made up of local Laotian rivermen, soon became most adept at catching the aircraft on its approach to the shore and making it fast. On departure, they learnt how to cast off and as soon as the engine caught, they would push the floats out into the stream so that the current would swing the nose around into the taxi position.

Normally the camps would move, always downstream, every two weeks, some 30-40 km. depending on a suitable camp site being available. Nearly all the parties built large bamboo rafts which besides being used to transport the camp equipment, were very useful to moor the Beaver, as the river bank was nearly always lined with sharp rocks.

Each party had two or three 15-ft. aluminium boats powered by an 18 h.p. Johnson outboard motor. These boats were very good for our purpose, as being light (they only weighed 260 lb.) they could be carried by three men. When moving camp the boats would tow the raft downstream carefully navigating through the rapids, fish barrages and other obstacles.

On arrival at a new site, the party chief would inspect the river by boat and choose a suitable alighting strip. This area was then carefully probed with bamboo poles for underwater rocks and snags. A taxi-way to the shore was also charted and, if narrow, flagged poles were placed in the river to guide the Beaver. The position of the strip, together with easily identifiable landmarks, was then radioed to base and flights commenced.

This system worked perfectly with one slight exception mentioned later. On arrival at a new site, Don did a dummy run to check for rocks which could easily be seen as a water discolouration from 1,000 ft. He also flew upstream a few miles to check on floating debris. Dead animals were the biggest menace as they are almost completely submerged, and a water buffalo can be a nasty thing to meet on touch-down.

The only accident that occurred during the seven months of operation was near Savannakhet on the river. An unexpected rock caught the Beaver just as Don was turning into wind. The starboard float hit, bouncing the plane out of the water, then it quickly settled again. Without waiting an instant, Don pushed the throttle almost through the windscreen and, as the aircraft was nearly empty, he got off the river, water streaming from the punctured float. He flew back to Vientiane and landed on the wheels.

Inspection showed a 3-ft. rip in the side of the starboard float just forward of the wheel well. Having had a look at the damage, it could easily be seen that had he hesitated or stopped to assess the damage the float would have become waterlogged, and with the forward movement of the plane it would have corkscrewed into the river. Knowing the strong current and depth of water at that site, the underwriters would have had little to salvage. Veha Akat had an excellent sheet-metal technician and, working overtime, the float was soon repaired and in operation again.

During the early months of the year the local hill tribes of Laos burn the forests to clear land for planting when the rains arrive. This creates a dense smoke haze which rises to 10,000 ft. and reduces visibility to a mile or less. Navigation during these months was very difficult, especially in the north of Laos, where huge sugar-loaf mountains rise up near the Mekong. We managed to keep the flights going and, after the first rains when the haze cleared, Don was heard to remark that visibility was so good he hardly recognized the route to the camp.

By and large the expedition was very successful, and this in no small measure was due to the excellent use that we had out of the Beaver. We would certainly recommend the use of an aircraft for resupply work in areas where communication is difficult, as although the cost is fairly high, the operation is saved from wasted time, through lack of some small part which could not be sent quickly to a party. This aircraft gave us no problems whatsoever and with normal maintenance under difficult conditions performed perfectly.

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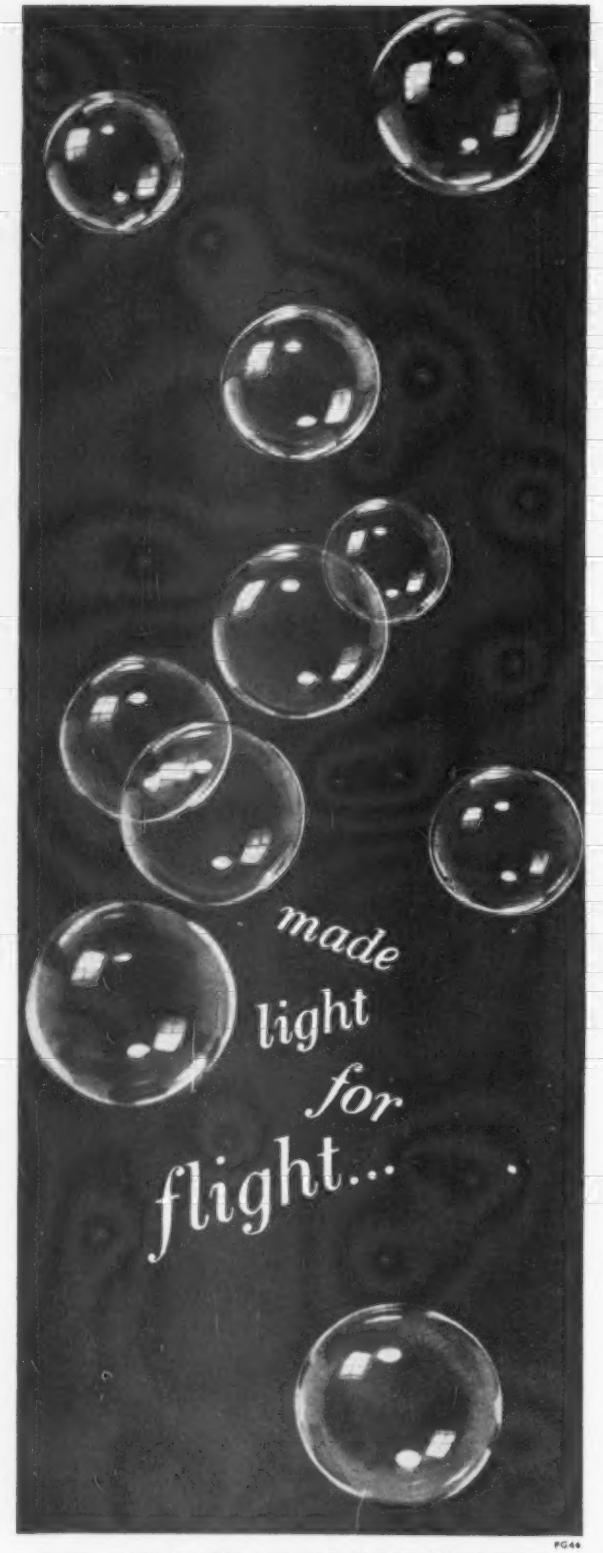

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Asian Royal Tour

TWO R.A.F. Dakotas have been chosen to carry H.M. the Queen and H.R.H. the Duke of Edinburgh on the Nepalese section of their forthcoming Asian tour. This decision has been taken by the Secretary of State for Air and the Ministry of Aviation after full consideration of possible types, including the D.H. Herons of the Queen's Flight and the Handley Page Herald.

The Herons do not have the carrying capacity for the task in Nepal, and although the Herald was fully capable, it had never been flown under normal military or civil airline conditions.

One of the two Dakotas—KN 645—was used by Lord Montgomery for some years after the War. Recently it had been held in reserve and was used periodically for special flights. The airframe of KN 645 has flown 2,888 hr. and its engines have completed 500 hr.

KN 452, the other Dakota, was recently brought back from Malta, where it was used by the A.O.C. for special flights. The airframe of this aircraft has logged 2,339 hr., and its engines have completed 327 hr. and 236 hr. respectively. Both aircraft are considered to be the best Dakotas in the Service and it is expected that they will complete four or five flights during the tour.

F.E.A.F. Administration

AIR VICE-MARSHAL J. F. HOBLER, C.B., C.B.E., who has been A.O.C., No. 25 Group, Flying Training Command, since October, 1958, is to become Air Officer in charge of Administration, Far East Air Force, in May.

In January, 1948, Air Vice-Marshal Hobler was appointed Deputy Director of Plans at the Air Ministry, and from April, 1950, until he joined Flying Training Command as Senior Personnel Staff Officer in May, 1952, he commanded R.A.F. Habbaniya. Prior to becoming A.O.C., No. 25 Group, he was Air Officer in charge of Administration, M.E.A.F.

Flying Training Command

AIR VICE-MARSHAL H. J. KIRKPATRICK, C.B., C.B.E., D.F.C., has been appointed Air Officer Commanding, No. 25 Group, Flying Training Command, with effect from the first of next month.

Since June, 1948, Air Vice-Marshal Kirkpatrick has been successively S.P.S.O., Flying Training Command, on the directing staff of the R.A.F. Staff College, Bracknell, Chief Instructor at the R.A.F. Flying College, Manby, a student on the 1954 Imperial Defence College course, and Director of Operational Requirements (A) at the Air Ministry. He was Assistant Chief of the Air Staff (Operational Requirements) before becoming Chief of Staff, 2nd T.A.F. in August, 1957.

Duncan Trophy Award

SHORTLY before retiring from his post of Commander-in-Chief, R.A.F. Germany, Air Marshal Sir Humphrey Edwardes Jones presented the Duncan Trophy to No. 93 Squadron at R.A.F. Jever last month. This award is for the squadron with the highest averages in operational ciné and air firing scored at the Armament Practice Station, Sylt.

This year's contest was won by No. 93 Squadron with the record averages of 91.6% for operational ciné and 40.3% for firing—the averages being computed from the best three scores in each phase. In the averages based on all personal scores, divided by the number of squadron pilots, the Squadron reached 86.6% and 34.4% respectively. Flt. Lt. R. D. Stone, "A" Flight Commander, achieved an average of 96.3% and 62.8%.

Commanded by Sqn. Ldr. M. O. Bregh, A.F.C., the Squadron is equipped with Hunter F.6s. This was its second win in the contest.

FINAL SALUTE.—Thirty-six aircraft from 2nd A.T.A.F. and a five nation guard of honour paid tribute to Air Marshal Sir Humphrey Edwardes Jones when he retired from the Service earlier this month. His post of C.-in-C., R.A.F. Germany, which he has held for three years, has been taken over by Air Marshal J. Grandy.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Wg. Cdr. W. Hoy, D.F.C., A.F.C., to the Department of the Air Member for Supply and Organization.

Fighter Command: Gp. Capt. R. J. Rackham, to Headquarters as Command Engineering Officer; Wg. Cdr. M. G. L. Lovell to R.A.F. West Raynham for air staff duties; Wg. Cdr. M. H. Constable-Maxwell, D.S.O., D.F.C., M.A., to Western Army Command as Liaison Officer; Wg. Cdr. A. Y. Mason, A.F.C., to R.A.F. Trimingham.

Coastal Command: Sqn. Ldr. P. A. S. Rumbold to Headquarters, No. 19 Group, for air staff duties with acting rank of Wg. Cdr.

Flying Training Command: Wg. Cdr. R. H. Fry, D.F.C., to Headquarters No. 25 Group for air staff duties; Wg. Cdr. J. R. C. Proudlock to No. 2 R.A.F. Police District, Church Fenton, as Assistant Provost Marshal; Wg. Cdr. P. D. Thorne, O.B.E., A.F.C., to R.A.F. Manby as Senior Instructor.

Technical Training Command: Gp. Capt. C. H. Press to the R.A.F. Technical College, Henlow, as Assistant Commandant; Gp. Capt. G. M. Robinson, D.F.C., to Headquarters as Senior Personnel Staff Officer; Wg. Cdr. A. G. Cadman to No. 1 School of Technical Training, Halton, to command the Administrative Wing; Wg. Cdr. D. W. Densham to No. 2 Radio School, Yatesbury, to command with acting rank of Gp. Capt.; Wg. Cdr. K. F. Massey to No. 3 R.A.F. Police District, Spitalgate, to command; Wg. Cdr. W. C. Vaughan, M.B.E., to the R.A.F. Technical College, Henlow, as Chief Electrical Instructor.

Signals Command: Wg. Cdr. E. R. Dutt, A.F.C., to R.A.F. Tangmere to command the administrative wing.

Maintenance Command: Sqn. Ldr. J. G. Ireton to No. 4 Mechanical Transport Squadron, Kidbrook, to command.

Other Appointments: Wg. Cdr. F. W. Davison to the Joint Services Staff College for directing staff duties; Wg. Cdr. R. W. G. Freer to the Ministry of Defence; Sqn. Ldr. W. E. Pettifer to the Army Staff College, Camberley, for directing staff duties, with acting rank of Wg. Cdr.

RECORD SCORE.—As recorded above, No. 93 Squadron has won the 2nd T.A.F. Duncan Trophy contest with record scores in both operational ciné and air firing. The Squadron Commander, Sqn. Ldr. M. O. Bregh, is seen in the centre of his pilots, with Flt. Lt. R. D. Stone, who achieved an average of 96.3% and 62.8% respectively, on his right.

THE AEROPLANE
and ASTRONAUTICS

Flying the Aircoupe Executa

by

John Fricker

Photographs copyright "The Aeroplane and Astronautics"

ALTHOUGH Fred Weick's novel Ercoupe first flew as long ago as October, 1937, it has continued intermittently in production ever since, and more than 5,000 examples have now been delivered. Its manufacturing rights and facilities have changed hands several times during its long career, in which it has grown from 55 to the current 90 b.h.p.

Production was recently taken over by Air Products Co., Inc., which, with a large financial backing, is manufacturing the renamed Aircoupe in an extensive facility at Carlsbad, New Mexico. There, production is continuing with three Aircoupe models, of varying standards of equipment. The Trainer is unpainted, and has only basic instruments, while the Expeditor adds a full panel, landing lights and Narco Superhomer radio. The Executa comes in a high-gloss two-tone finish fully equipped for night and IFR operation.

All three models are now being handled in the U.K. and north-eastern Europe by a new British company, Air Rent, Ltd., whose principals are Mr. K. Couling and Eric Thurston, at Stapleford, Essex. Seven Aircoupes are already in stock, together with a substantial spares backing, and are being offered at U.K. delivered prices of about £3,500-£4,200, according to model. Their American private Cs. of A. have already been validated, and they have been submitted for full public transport categories.

At the moment the Aircoupe is the only low-wing fixed tricycle-undercarriage American aircraft available in this country, and should be accordingly popular. I must confess to a very soft spot for the original design (this series, May 9, 1952), having used the only Ercoupe in Britain, until the recent "invasion," for a couple of years on business flights. During that time, I did more than 90 hr. on it which I think qualifies me to express an informed opinion on its unique two-control system.

Like everyone else, I disliked this for the first hour or so, but after the initial period of thrashing my feet round the floor for non-existent rudder pedals, I settled down to enjoy what proved to be a singularly simple, logical and foolproof system. I flew it from runways with various degrees of cross-winds at airfields all over the country, and used it exactly like a motorcar. As your only control was a wheel, you simply steered the thing along the runway for take-off and carried on driving in the air.

From talking to light aircraft pilots, I find that most are opposed to the idea of two controls, particularly those who have not tried them. In deference to popular opinion, separate rudder controls have long been fitted to the Aircoupe series, and the de luxe Executa which I flew at Stapleford and Elstree was so provided. The two-control version is still available, and *inter alia* is probably the only aircraft which could be flown by some disabled pilots.

Examination of the glossy Executa demonstrator, G-ARHA, showed duplicate and very narrow-set rudder pedals in the two-seat cockpit, which has space for a third (child's) seat in the rear, or an equivalent 75 lb. of baggage. The rudder pedals are now used for nosewheel steering, in the standard American fashion, instead of being linked to the control wheels, which still retain the large degree of rotation of the former arrangement. Coupled with the full-span ailerons, this results in very positive lateral control.

Other slightly unorthodox features of the control system include restricted movement of rudders and elevator. The latter has had a large central "bite" taken out of it since the Ercoupe days, and has 20 degrees instead of the original 13 degrees up-travel. Rudder travel is equally limited, as the surfaces are prevented from moving more than 3 degrees inwards by the lack of elevator cut-out, which means that only one of them moves effectively (outwards) at a time.

This is for optimum safety; a stall breakaway is not normally possible, and the Aircoupe is F.A.A. certified as characteristically incapable of spinning.

Inadvertent spins cause many light aircraft accidents, and any means of so positively preventing them must be welcomed. Control travel in the Aircoupe is still entirely adequate, and the restrictions are not normally apparent.

Cockpit entry, via the two wing walkways, is simple, despite the fairly high sidewalls and the necessity to step on the three-position seats. For the latter purpose neat fold-down mats are provided. The Aircoupe retains the excellent "roll-top" type side-windows of the earlier variants, with an optional sliding centre-piece of green plastic. All three components can be moved to various positions around the windscreen and rear canopy arches, or for a 5 m.p.h. cruising penalty, both side-sections may be slid right down to give virtually an open cockpit.

Cockpit layout remains similar to earlier variants, but the Executa has a full flight panel to port, except for a VSI, and a useful radio installation in the centre. This normally comprises a Narco VHT-3 Superhomer, with VOR indicator, a Narco LF and MF receiver with provision for addition of a manual loop. Reception is via a speaker at the rear of the cabin, the noise level being sufficiently moderate for this

to be effective. Lighting equipment extends to a rotating anti-collision beacon beneath the fuselage.

The 90-b.h.p. Continental C-90-12F starts easily with a pull on the central handle and after a few pumps of the throttle plunger, with its vernier lock, for priming. Like the Tri-Pacer and other of its contemporaries, the Aircoupe has a single central brake lever of the fly-off type, which gives very positive non-differential action via disc units on the mainwheels. These have levered suspension and, with the nosewheel, about a 12-in. stroke, for a soft and well-cushioned ride.

Ground manœuvrability is excellent with the help of the easily steered non-castoring nosewheel, and the really exceptional all-round visibility is apparent from the ground up. Pre-flight checks are confined mainly to fuel and trim states, having no flaps to worry about. The original fuel system of three tanks is retained, the wing-root containers holding 7½ Imp. gal. per side and the front bulkhead tank, 5 Imp. gal., giving an excellent overall capacity of 20 Imp. gal.

Each has a filler cap, but they cross-feed, and there is a single car-type gauge for the wing tanks in the port cockpit wall, where it is difficult to read without the help of its night-flying light. The front tank, into which the wing tanks feed, has its own wire float indicator, and can be regarded as a useful hour's reserve, after the main tanks read empty.

Trim operation has been changed, rather regrettably I think, to a knob between the seats, actuating a screw-jack with an attached indicator scale. It is low-geared but not over-powerful, and demands much clockwise twisting to wind it from full-nose-down to full nose-up. The latter position is used for take-off (and landing) at all C.G. positions, although the out-of-trim loads are never high.

Take-off, for minimum run, also requires full aft elevator, which gives a very positive unstick technique. It means that, with the wheel hard back, it will fly itself off the ground precisely at the correct speed. This usually happens at about 55 m.p.h. according to load, after a refreshingly brief run. Very little attention to nosewheel steering is needed to keep straight, although some right rudder helps during take-off and climb.

Solo, the Aircoupe reached 1,000 ft. in 1 min. 10 sec. from unstick, while with two up and three-quarters fuel, the time was 13 sec. longer. Both rate (844 and 720 ft./min.) and angle of climb, at 70 m.p.h., are obviously good. Levelled out for the nose-down cruise, with a few twists of the trim knob, and throttled back to 2,300 r.p.m., the airspeed indicated around 110 m.p.h., at which it will return well over 24 a.m.p.g.

Initial acquaintance with G-ARHA proved slightly strange, in that use of the rudders during normal manœuvres results in little apparent effect. In fact, first pressure on the close-set pedals seems to accomplish very little, and not until almost full travel seems to have been reached does the Aircoupe start to yaw. This, of course, is deliberate: no yaw, no spin.

Foot pressures are very light, as are all the controls, which makes for good co-ordination and pleasant flying, and the Aircoupe is best flown almost in its original manner, as a two-control aeroplane. Forgetting the rudder, the full-span ailerons give an effortless rolling reaction, the top needle of the turn-and-slip staying central throughout. True, it is now possible to sideslip during the glide but, with the small rudders and so much dihedral, slip angle is small.

Being unusually light and lively for an American aeroplane, and with an above-average view, the Aircoupe has rather a more sporting atmosphere than most of its contemporaries, although the high quality of its interior finish is fully up to standards of executive travel. For a little aeroplane, its resistance to turbulence in rough air is surprisingly good, although directional stability could be made slightly more positive by some additional fin area.

To get the Aircoupe to stall, it was necessary for A.R.B. test pilot Geoff Howitt to put 10 lb. excess weight in the 75 lb. baggage compartment, and to empty the wing tanks, which put the C.G. way behind the aft limits. He then achieved a mild breakaway at about 38 m.p.h. I.A.S.

When I tried the low-speed performance in still-air, I was solo, with almost full fuel, at a forward C.G. I found that power off, with the wheel on its aft stop, the Aircoupe sank nose-high at a steady 47 m.p.h. I.A.S., with plenty of lateral control, descending at a moderate 600 ft./min.

To keep straight, quite a lot of right aileron and full left rudder was needed, but despite these crossed controls, there certainly seemed no possibility of a spin. It would never be possible to apply enough yaw, even if you could achieve an accelerated stall.

Landing the Aircoupe is too simple for words. Although flapless, the approach is not excessively flat. As long as you get 65-70 m.p.h. on the A.S.I. over the hedge, the elevator remains so sensitive that you can brush the wheels through the grass before gently settling on the long-stroke oleos. You can then lower the nosewheel for full directional control and braking.

Apart from its touring capabilities, the Aircoupe would clearly make an excellent trainer in the modern manner. Its all-metal structure and undercarriage are very robust, it should be cheap to run, and you can see out of it in the circuit. There are not many light aeroplanes to which all these qualities can be applied.

Leading Particulars

Dimensions.—Span, 30 ft.; length, 20 ft. 2 in.; height, 6 ft. 3 in.; wing area, 142.6 sq. ft.

Weights.—Empty, equipped, 933 lb.; fuel, 20 Imp. gal., 144 lb.; oil, 8 lb.; payload, 365 lb.; max. gross, 1,450 lb.

Performance.—Max. cruise, 120 m.p.h.; service ceiling, 15,500 ft.; absolute ceiling, 18,000 ft.; initial climb, 700 ft./min.; take-off distance, 500 ft.; landing distance, 600 ft.; range, 500 miles.

With its long-stroke undercarriage oleos extended (left), the Aircoupe Exacta is posed by the author in winter sunshine alongside the photographic aircraft. In the plan view, above, can be seen the full-span ailerons and revised elevator contours of the all-metal Aircoupe.

Aircraft Structural Materials

An assessment of present and future developments by PROFESSOR A. J. KENNEDY,* Ph.D., A.M.I.E.E., F.I.M., F.Inst.P. *Aero-engine materials will be discussed next week by* Dr. T. A. TAYLOR of N.G.T.E.

SO far as aircraft structures are concerned the materials situation has reached an interesting phase of development. Up to the present time it might be said that aeronautics has exerted two major influences on alloy development: first on the evolution of high-strength light alloys for structural applications, and secondly on high-temperature alloy development for engines, particularly gas turbines.

The point has now been reached when quite new factors are beginning to exert their influence, and it might therefore be opportune to attempt some survey of the overall situation, not in contemporary terms alone, but with an eye to the probable longer term evolution of aeronautical and astronautical vehicles. This survey is essentially confined to structural materials, but reference will be made, where appropriate and relevant, to engine applications.

From a structural point of view, the designer requires materials which are cheap, strong, tough, light; easily formed, fabricated and joined; with high moduli and a reasonable work-hardening range, and with good resistance to deterioration under exposure to stress and environment. Materials selection and utilization are self-evidently matters of compromise.

In the past the aluminium alloys have embodied the optimum combination of properties for general structural applications and it is largely due to improvements in this class of material that aeronautics has been able to attain its high level of technical achievement. Within this class, there have been clearly observable trends, particularly in the past 15 years or so. Increasing speeds and all-up weights, and higher flight altitudes have elevated the importance of dynamic

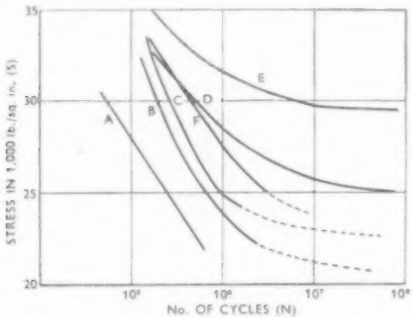


Fig. 1. The effect of composition on the fatigue characteristics of Al-Zn-Mg alloys, after Polmear. A—8.3Zn 1Mg; B—5.8Zn 2Mg; C—5.1Zn 3Mg; D—4.5Zn 4Mg; E—4.1Zn 5Mg; F—3.7Zn 6Mg. This improvement in fatigue strength is achieved at the expense of some loss in proof stress.

stresses, and of cyclic stresses generally, relative to static strength considerations.

The very high strength light alloys, with all their obvious advantages, have not lived up to the hopes originally entertained of them under such conditions. It is not that their properties are particularly inferior on an absolute scale, but rather that relative to their static strength their fatigue resistance is disappointingly low. It is also true that their fracture characteristics, particularly the nature of crack propagation, have caused very serious concern and has resulted in their replacement for many applications by lower-strength materials.

It would be unwise to deduce from this that the achievement of higher strengths in aluminium alloys must inevitably introduce metallurgical factors which seriously reduce fatigue and corrosion resistance. At the present time, research evidence is somewhat conflicting, but it does seem that changes occur in the aluminium-zinc-magnesium alloys under alternating stress, probably of an aging character, which contribute to the lower fatigue resistance by creating small local regions which are essentially over-aged. This may turn out to be a false interpretation, but there is now no doubting the direct experimental evidence which demonstrates that this class of alloy does exhibit changes which are not detectable in other precipitation-hardening alloys, such as those of aluminium-copper.

It is not known, as yet, whether further alloying, or special heat-treatment sequences, can improve the properties in this respect, but it is at least a serious metallurgical possibility. There is, in fact, very positive evidence that fatigue life can be much improved by varying the proportions of zinc and magnesium in these alloys, but unfortunately this improvement results in an unacceptable reduction in some of the static properties, such as yield point (Fig. 1). However, it should be made clear that there are at least reasonable possibilities of an improvement being brought about by metallurgical studies, so that we can say that the limits of the aluminium alloys have probably not been reached as yet.

As it happens, the primary consideration in the utilization of light alloys in aircraft structures in supersonic aircraft takes a somewhat different form. The main research effort at the present time, in this context, is the fall-off of the mechanical properties with temperature in the approximate temperature range 100° C. to 170° C.

Retention of strength at a mean working temperature of about 130° C. is a major factor in a material which is to resist the skin temperatures generated at speeds of Mach 2-3 for times of up to 30,000 hours. Not only is a direct resistance to stress at such temperatures required, but so also is a resistance to exposure at these temperatures; even in the absence of any very significant stress.

Certain alloys emerge as better than others under such conditions, and notably the alloy Al 2.5Cu 1.5Mg 1.0Fe 1.2Ni 0.25Si 0.1Ti (RR 58) and the experimental alloy Al 4.5Cu 0.2Fe 1.0Li 0.5Mn 0.2Cd 0.1Si (X 2020), which is distinguished by its lithium content. Generally speaking, the alloys RR 58 and the SAP-type materials are less attractive at the lower, more conventional, structural temperatures, but retain their properties better over about 100° C. (Fig. 2).

Quite different physical principles are involved, of course, in extending the temperature range in which an alloy is useful compared with those which apply to strength improvements (static or fatigue) at lower temperatures. The time-dependent processes which restrict higher temperature applications are thermally activated and of a so-called *diffusional* type.

Without entering into matters of metallurgical detail, it can be said that once diffusion rates become finite, compared with the time scale of the temperature-cycling, then a number of issues become of serious practical concern. Some of these are essentially mechanical—creep, for example, or the loss of work-hardening by thermal exposure (recovery); while others are indirectly mechanical—aging and precipitation processes, for example. The activation of these processes is an inescapable consequence of raising the temperature, and whatever improvements alloying additions may effect (and these are real and

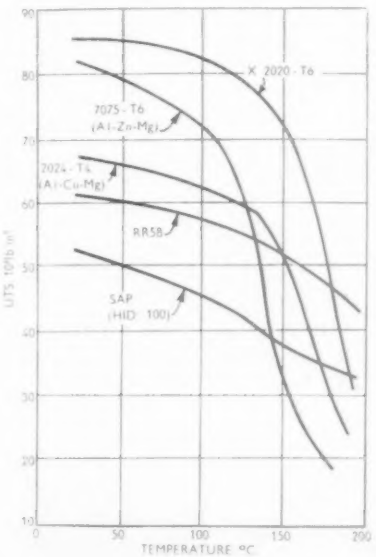


Fig. 2. Comparison of the dependence of ultimate tensile stress on temperature for various light alloys tested after 1,000 hr. exposure to the test temperature.

* Head of the Department of Materials at the College of Aeronautics.

valuable benefits) there is a fundamental limit to the degree of improvement which is possible, set by the rate of self-diffusion of the base element—in this case aluminium.

While, then, the properties of light alloys may edge forward as metallurgical research develops, they will not profoundly transform the present situation as far as supersonic aircraft are concerned. They may, however, make striking improvements possible in subsonic aircraft.

We should distinguish, in making any such assessment, those materials which depend for their high temperature resistance on the fine dispersion of a separate, insoluble phase. A good example, in connection with the aluminium alloys, is SAP (sintered aluminium powder). This is an aluminium alloy stiffened by a network of oxide which, while it positively improves the high-temperature resistance, exerts a deleterious effect on the normal room temperature properties of the alloy (Fig. 3). At the present time, this is a factor which makes it unacceptable as a structural material.

However, the principle of dispersion-hardening, that is, the admixture of fine, hard particles to a metallic matrix, is one which should commend itself to aeronautical interests, because strength at temperature can be achieved (theoretically) by the use of low-density materials. The exact mechanism of dispersion-hardening is not easily explained in simple terms—indeed it is imperfectly understood anyway—and a proper discussion of it would certainly require a presentation of the problem in terms of metal physics and dislocation theory, and this would be out of place in an article of this type. Dispersion-hardening, however, is a question which is of very great long-term interest to materials engineering as a whole, and one which deserves serious research.

Essentially, the dispersion-hardened materials exemplify once again the dual requirements of all useful engineering materials: strength with toughness. The particles which form the dispersed phase are hard and brittle, intrinsically stronger than the continuous matrix, but useless in isolation, because of poor impact resistance and low ductility. The metallic matrix itself has the requisite ductility, but lacks strength at temperature.

A combination of the two, if suitably designed, can effectively combine some of the qualities of both, but only, it seems, in some intermediate temperature band. At lower temperatures the properties of the material are worse than the metallic matrix, while at much higher temperatures the properties are inferior to those of the dispersed phase in isolation, as it were.

Whether or not the addition of such particles must necessarily reduce low temperature strength is a question which is still unresolved. The boundary between particle and matrix here exerts a critical influence: the stress-raising action of the particles might well be diminished if a more plastic boundary layer could be formed.

As aeronautics and astronautics develop in the future, new materials will certainly need to be brought into use, particularly for the very high temperature components. While the critical applications may be in propulsion units, structural heating, particularly at leading-edges, and in the nose-cones of re-entry vehicles, exercise a serious limitation on materials design.

The first point that might be made is that the knowledge already gained in pressing forward materials for high temperature service in propulsion units is of immense value and importance to structural engineering. To date, the guiding considerations which engineers have applied in selecting and utilising materials for engines have differed markedly from those applied to aircraft structures.

The incentives to serious metallurgical research have also differed. Thus, while the nickel and cobalt alloys have been improved enormously as far as their temperature resistance is concerned, no similar line of development has been undertaken with the light alloys.

Much, then, is to be gained by drawing upon the metallurgical knowledge acquired in the high-temperature field in assessing the capabilities and the future possibilities of alloys of aluminium and magnesium, as well as structural steels.

The second important point is that current difficulties of a technological character, with certain materials which would otherwise be highly suitable from the point of view of final properties, should not be regarded over-seriously. Forming and fabrication difficulties can be overcome provided sufficient effort is applied. The effort may prove expensive, and economic factors are important, but many more things are possible with such materials than is generally accepted.

Aeronautical requirements have always pressed materials technology to new limits and the same thing will certainly happen with stainless steels when these become standard structural materials. Within the present range of available materials there is, then, much margin for development.

The phase now being entered by aircraft engineering is one which brings a radical change in the controlling metallurgical factors. A series of new considerations arise which require much more detailed fundamental studies, particularly those relating to creep and fatigue effects. There is, however, little

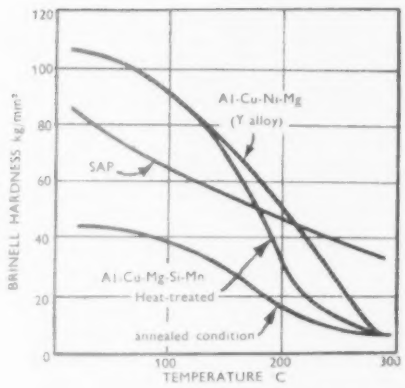


Fig. 3. Comparison of SAP (Hid.100) with Y alloy and Avional alloy in two conditions, after 700 hr. at temperature.

reason to doubt that the next generation of high-speed aircraft can be successfully brought into being.

In the somewhat longer term, much more serious obstacles will be encountered in dealing with high-temperature problems. There is, of course, an absolute limit to high-temperature advance, set by the melting points of the elements. This we have to accept. Nevertheless, we still have a great way to go in exploiting materials of high melting point.

In many cases, increased strength is readily attainable provided surface attack can be prevented—molybdenum, for example, suffers catastrophic oxidation above about 700° C., but would otherwise be very advantageous. Alloying can improve the situation, but other difficulties arise, such as recrystallization, which virtually removes any increased strength built up by the work-hardening processes.

Protective coatings are, therefore, highly important, not only because of thermal protection, but also because of erosion resistance, a question which is of special significance in the case of surfaces subjected to the impingement of a high-velocity gas stream. Effective coatings must, of course, be resistant to the environment, but must also be strongly bonded to the underlying structure. In addition, this bond must be capable of resisting the operating conditions, particularly the thermal stresses generated by differential thermal expansions and by temperature gradients.

An excellent solution to this problem would be the utilization of a high-temperature metal which forms a refractory oxide. Unfortunately, those metals which form such oxides (such as aluminium) are not high melting point materials, and conversely the more refractory metals have non-refractory oxides.

Aeronautics has an obvious interest in all low-density materials, and it is worth noting that two materials which are exceptional in this respect have not, so far, been utilized to any serious degree. The first of these is beryllium, which has a markedly lower density, and higher modulus, than other elements with comparable melting points (see Fig. 4): indeed, its modulus/density ratio is quite exceptional anyway.

In fact, from a cursory survey of the properties of all the elements one would come to the conclusion that beryllium was the most valuable of them all for aeronautical applications, and it is therefore worth giving some consideration to the reasons why it is not in use at the present time. Beryllium aircraft would, for example, make it possible for structures to be reduced in weight by about one half, and the weight saving would be even more marked at higher operating temperatures.

While the density of beryllium is about the same as that of magnesium, its modulus is four times higher than that of aluminium and consequently it shows up extremely well when its properties are compared with certain other alloys. But it is expensive; the cost of a finished beryllium structure would probably work out to be at least £50-£70 per lb. At this price, however, the actual operating cost of a beryllium aircraft would be less than that of a similar aircraft built in aluminium alloy, because of the extended range made possible by the use of the lighter structure.

Another difficulty in the use of beryllium is that considerable precautions have to be taken in operations such as machining, where finely divided particles may be released into the atmosphere. As a consequence, many of the standard fabrication operations require extensive modifications to make them safe and these can be expensive.

From a point of view of properties, the real limitation of beryllium is its lack of ductility, which certainly makes it unacceptable at the present time as a structural material. The fundamental reason for the brittleness of beryllium has not been established, but certain theories do exist and the researches

which these have prompted might well lead to results of practical value. It would certainly be wrong to assume that brittleness is an inescapable problem with beryllium.

The other outstanding element which might be noted in a speculative way is graphite, which has a density of about 2.0 in the conventional form, and a very high melting point (in fact at normal pressure there is no liquid phase with graphite as it sublimates directly to vapour at approximately 3,700° C.). For extreme temperature resistance—for example, in rocket nozzles and in leading edges and nose-cones—graphite is probably the most effective material for resisting the action of the environment.

Normal grades of graphite are certainly disappointing in many of their mechanical properties which are far below those that would normally be required for such applications. For example, at lower temperatures (up to 1,500° C.) graphite has zero ductility, and its modulus also is far lower than the metals of high melting point. However, at operating temperatures in the region of 3,000° C. and above, there is no other material which combines thermal resistance with a reasonable combination of physical properties in the way that graphite does.

The big change in the graphite situation of recent years has been the development of a new type of product deposited from the vapour and termed pyrolytic graphite. This is distinguished from the so-called conventional graphite by having a highly oriented structure, and by a higher density, coupled with better mechanical properties.

Graphite has the very great advantage that loss of surface material at high temperature (ablation) is by a sublimation process, and hence a large amount of energy is dissipated directly, because the energy required to remove a carbon atom from the graphite structure is extremely high. Not only is the magnitude of this energy an advantage, but sublimation is a more useful process than melting because, under the action of the high velocity gas stream, the liquid phase is swept off the surface and no advantage can be taken of the latent heat of vaporization.

Unfortunately, graphite does not behave in this ideal way in practice; presumably because particles of the surface are eroded out mechanically by the impinging gases. Consequently the energy dissipation which could be taken up in a pure sublimation process is not in fact achieved. In spite of this, at the present time most of the advanced projects which are concerned with very high speed vehicles, of one form or another, have been designed in terms of graphite inserts for those parts of the structure which experience very intensive and rapid heating.

It is also true to say that the more advanced types of graphite (and mention might here be made of developments in the production of graphite under very high pressures) have not yet been brought into use for such applications, simply because their successful evolution is a very recent achievement.

Success in this direction will depend, as in many other cases, on the degree to which composite structures can be developed. Indeed, this might well be taken as the theme of longer-term materials advance, which must surely depend very largely on the extent to which different materials, with markedly different properties, can be assembled into a compatible structure. Such requirements will certainly promote new lines of research, particularly into boundary properties, the nature of adhesive bonds, inter-diffusion, and, indeed, into the actual methods of stress analysis for such structures when these are subjected to complex thermal conditions.

This brief assessment cannot, of course, do justice to the underlying metallurgical considerations which would need to be argued in some detail for their proper appreciation. However, some general conclusions can be drawn which might, perhaps, be summed up as follow:—

1. Aeronautics is entering a new phase so far as materials engineering is concerned. Structural design must necessarily adopt a somewhat different philosophy, and this can be modelled with profit on the experience gained in developing high-temperature materials for engine applications.

2. The new considerations brought about by high speed flight, and notably the concern for the time-dependent properties of materials, will certainly prove a stimulus to new researches on the light alloys which may, in turn, yield results of benefit to aeronautics as a whole—that is, to subsonic aircraft as well. The same incentive will certainly promote a range of developments in fabrication and finishing techniques on materials hitherto regarded as prohibitively difficult.

3. The proper design and construction of high-speed aircraft (say Mach 2 and above) requires more research into basic properties, particularly in connection with fatigue and with deformation by creep. The possible interaction between these two processes is also a major concern, particularly with light alloys where the design is more critical. There is no serious problem so far as the availability of possible future materials is concerned: stainless steel is suitable and practical.

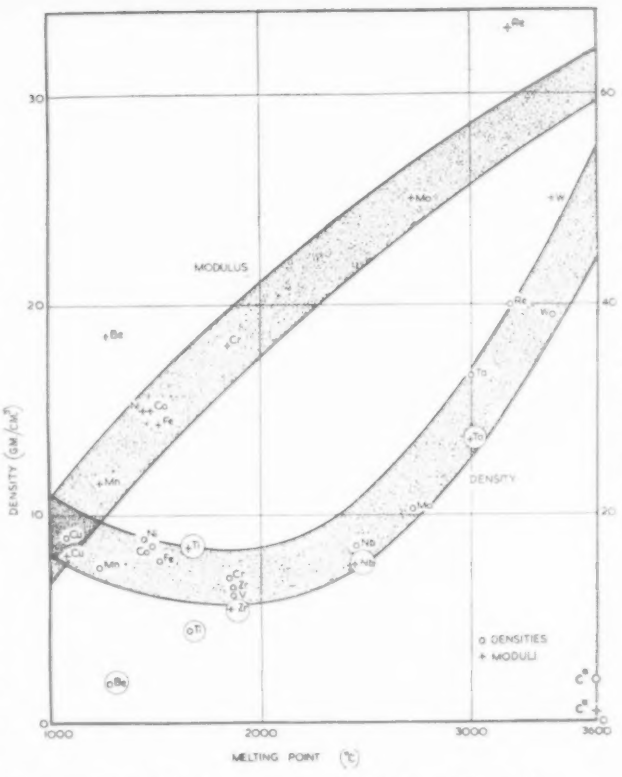


Fig. 4. The trend of the room-temperature modulus and density of elements with melting point. Beryllium and graphite are distinct exceptions to the general trend. Graphite (indicated by C°) has no melting point at atmospheric pressure.

The most efficient, the most economic, and the safest steel structure, and the combined engineering and metallurgical questions raised by its fulfilment, are, however, complex and difficult matters. Exact knowledge is still all too scarce.

4. More ambitious projects in the future will impose operating conditions which cannot be met by existing materials. For a time we may proceed by extending the use of the so-called engine materials to the structure itself, accepting the weight penalty which this imposes. Ultimately, however, the available temperature margin will be used up unless we embark upon serious and intensive research along those lines which appear to give some hope of radical improvement.

Notable fields which commend themselves in this connection are those of dispersion-hardening, very high-pressure forming, and surface coatings. Research on these lines will be more effective, so far as vehicle structures are concerned, than developments towards higher temperature alloys based on the refractory metals of high density.

5. Beryllium and graphite both possess obvious advantages as structural materials, but at present they are both handicapped by severe limitations. If these limitations can be overcome then their successful utilization in aircraft structures could seriously transform the whole situation. Again, the immediate need is for a better understanding of the fundamental properties, and this can only be achieved by intensive basic research.

6. There are a number of materials questions of general concern to aeronautical engineering: creep, fracture, fatigue, brittleness, and so on. With the better fundamental basis which more recent theory has provided, progress towards an understanding of these processes is going forward more confidently, with the possible exception of fatigue, which is still difficult to explain satisfactorily in terms of a fundamental physical mechanism. Even in this case, however, much more realistic interpretations of the character of early fatigue damage have now been made.

It would, perhaps, be fair to say that understanding of the basic nature of many of the mechanical properties of metals will advance strikingly in the next five years. If this occurs, the possibilities of developing materials more resistant to the anticipated operating stresses and temperatures will become much clearer, and practical improvements in materials properties might well follow fairly quickly.

7. In advanced aeronautical and astronautical projects, the rôle of materials is a critical one. Engineering and metallurgy must come much closer together if these projects, which are theoretically feasible, are to be successfully realized in practice.

Simulating Visual Flight

THE realistic visual presentation of the outside view through the windscreen of a flight simulator during the take-off and landing phases of flight is now considered a major requirement by both military and civil operators. In particular, the value of synthetic training is increased considerably with the possibility of completing an instrument or route flying exercise with a transition to visual flight conditions for the final approach and landing on to the runway.

Work in this field of visual flight simulation has been in progress for a number of years, both in this country and the United States, and among the manufacturers engaged in the development of such aids is General Precision Systems at Aylesbury. Starting in 1958, the Air Trainers Link Division of the company has now completed work on a prototype unit and is ready to go into production with its simulator visual flight attachment.

By comparison with some systems, the G.P.S. unit is very compact and can be employed with both static and moving flight simulators. The principle of viewing a model terrain with a closed-circuit television camera system is used for producing the required outside view—which is presented to the pilot either by a projector and a screen, or by a directly viewed television tube.

The terrain model is constructed on the outer surface of an endless flexible band which passes over two rollers mounted in a vertical frame. This band is driven according to the computed component of the simulated aircraft's ground speed and is illuminated by lamps distributed in an overlying frame, so that directional shadowing as well as general illumination is obtained. Three outside conditions—daylight, dusk and night—can be simulated by switching.

In the prototype equipment a scale of 1 in 2,000 has been employed and, with a 36 ft. 6-in.-long by 10-ft.-wide band, the total terrain area represented is 12 n. miles long and extends 1.65 n. miles on each side of the centre line on which the airfield runway is positioned. The maximum possible cloudbase or break-out height has been set to meet the M.o.A. requirement of 1,200 ft., and the maximum visibility from the simulator windscreen is 4.4 n. miles.

In addition to the general model lighting from above, the airfield's runway and approach lighting system is represented in the band by means of Perspex reflecting devices which are illuminated from behind.

Mounted in a horizontal plane on the outside of the band and slightly above the lower roller, the camera system is at right angles to the surface of the model, which it views upwards by means of a small prism or mirror set at 45°. The left/right position of the aircraft relative to the centre-line of the runway is obtained by the movement of the camera across the width of the model, and changes in simulated height are made by moving the camera towards or away from the model.

Changes in aircraft attitude and heading are simulated by the movement of the internal optical system and not by the complete rotation of the camera. A change in pitch, for example, is obtained by the rotation of the pitch prism about its horizontal axis.

Visual range and cloud conditions are fed in by the electronic adjustment of two cards within the TV channel; these can be adjusted from the operator's console within set limits to meet any particular requirement. Visibility can be set at any distance between 300 ft. and 4.4 n. miles and the cloudbase can be varied between 1,200 ft. and airfield height. Although simulated conditions of day, dusk and night are at present produced by adjusting the general model lighting, this can also be undertaken electronically by adjustment to the brilliance of the TV tube.

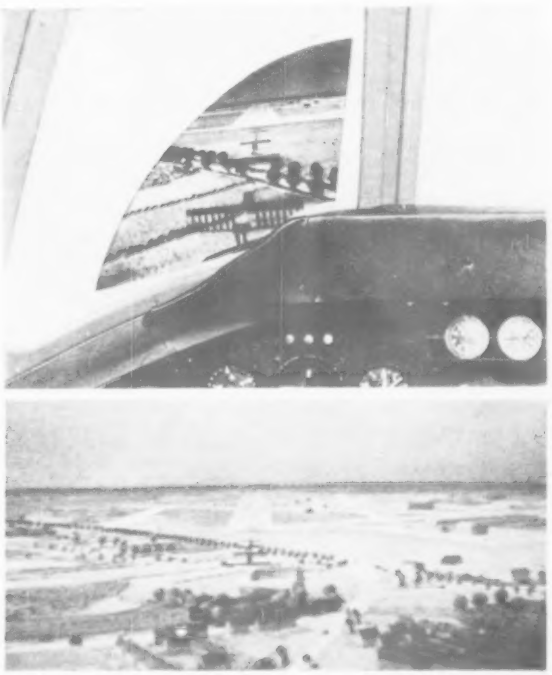
As already stated, there are projection and direct viewing television systems for presenting the outside view to the pilot. The projection system comprises a projector mounted on top of, or adjacent to, the flight simulator fuselage and a 12-ft. by 9-ft. screen. The alternative system, direct viewing, involves the mounting of a television tube immediately in front of the viewing pilot's section of the windscreen.

Attached to a basic four-engine turboprop trainer, the G.P.S. prototype visual flight unit has the projection system installed for the aircraft captain and a 17-in. 625-line TV direct-viewing monitor for the co-pilot. Other possible combinations are two projection systems or two direct-viewing tubes.

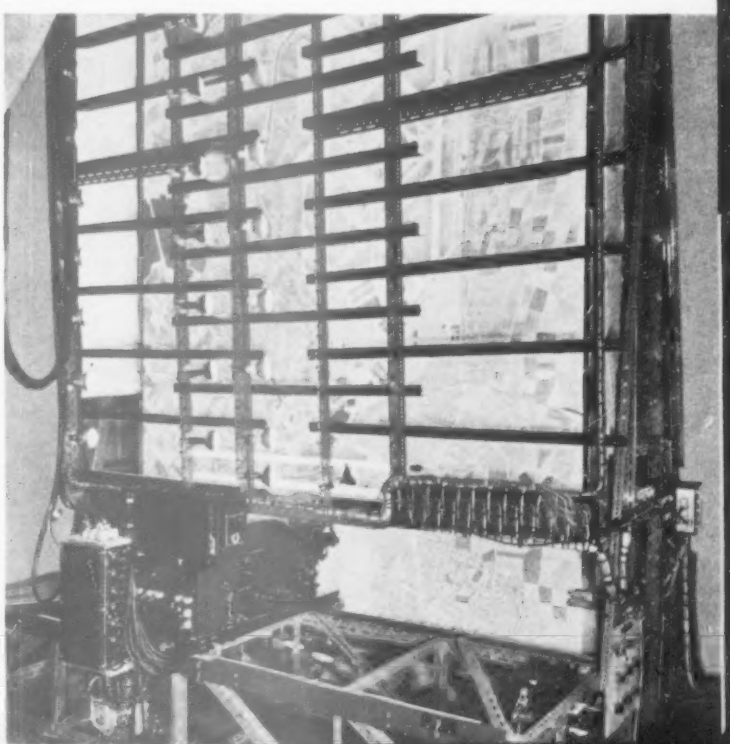
To overcome the so-called "tunnel" effect of seeing the edges of the visual presentation, G.P.S. have used the sweep of a windscreen wiper to limit the view of the pilot when looking out of the cockpit.

In addition to the environmental and map-size limitations already stated, the unit has an overall height limitation of 1,500 ft. above the airfield and the picture is automatically obscured if the aircraft turns through 30° from the runway before reaching the pre-set cloudbase. The maximum simulated ground speed of the unit is 200 knots.

Operators with a requirement for this type of visual simulator in this country include the R.A.F. and the two airline Corporations. G.P.S. has not yet started to manufacture any product units, but estimates the order-to-delivery period at nine months. A standard unit for attachment to a single simulator is priced in the region of £40,000.



Top, the view through the sweep of the windscreen wiper in the type trainer fitted with the prototype G.P.S. visual flight attachment. Above, part of a typical presentation of a simulated approach on to a runway. Right, the prototype model unit comprising band mounting assembly together with camera and optical system.



Probes to Venus

January is a suitable month for launching probes to the planet Venus. Some of the factors involved are reviewed in this article by S. W. GREENWOOD, M.Eng., A.M.I.Mech.E., A.F.R.Ae.S. *Russia has yet to launch a probe within the Earth's orbit, and this may prove an appropriate opportunity.*

VENUS is a planet of mystery. Although it approaches closer to the Earth than any other planet, and in spite of its close resemblance to our native planet in size and mass, we know practically nothing about it.

The main reason for this is that it is shrouded by a substantially opaque atmosphere. Moreover, the planet lies between us and the Sun, so that when it is nearest to us we are looking at the shadow side. As is always the case when information is scant, the limited nature of the data available on Venus has led to considerable, and often heated, speculation on the conditions that may be found beneath the envelope of atmospheric gas. The exploration of this planet, first by probes and later by man, presents a fascinating prospect.

Venus orbits the Sun at a mean distance of just under 3/4 of an Astronomical Unit. The orbit is more nearly circular than that of any other planet, and is slightly inclined to the ecliptic. The planet has an escape velocity that is 7% smaller than that of the Earth, so that it may be treated in a broadly similar manner to our own planet from the astronautical viewpoint.

Its extensive atmosphere is known to possess a strong CO_2 content, and it is believed that it consists largely of this gas. Recent investigations have indicated that atmospheric entry problems for Venus are similar in their severity to those for the Earth, though they would be met at a higher altitude on Venus.

A number of techniques have been employed in attempts to determine the rotational period of the planet about its axis, and estimates vary so widely that little confidence may be placed in any of them. It appears that the period is fairly large, probably several weeks.

It is thought that Venus is tilted on its axis by roughly the same amount as the Earth, about 23°. As the planet lies closer to the Sun, one would expect it to be warmer than the Earth. Data obtained by radio astronomy indicates a temperature of about 300° C. at the surface. Temperatures in the upper atmosphere are around 0° C.

There is now strong evidence that the planet possesses an appreciable magnetic field. It is therefore almost certainly surrounded by strong radiation belts.

The orbits of Earth and Venus are shown in Fig. 1. Venus travels over a shorter path at a higher speed. It overtakes the Earth about every one year and seven months, and the period when it is coming up on the Earth from the rear is the most favourable one for launching probes from the Earth towards it. Such a period occurs this January. Ehricke has suggested that the period Jan. 11 to 25 is the most suitable, partly as this permits the transfer orbit to be of low energy, and partly because higher energy orbits present difficulties in the Sun lying behind the line of sight from the Earth to the probe during flight.

The minimum-energy transfer orbit is a semi-ellipse touching the planetary orbits as shown. This is often referred to as a Hohmann orbit. The launch date must be selected so that the probe arrives at or near the orbit of Venus at the time the planet is there also. The journey time between the planetary orbits is 146 days, or almost exactly 2/5th year.

In the likely event of a probe missing Venus, it would thus return to the Earth's orbit at the end of 4/5th year. The probe would be expected to meet up with the Earth again after four years, when the Earth had travelled four times around the Sun and the probe five times.

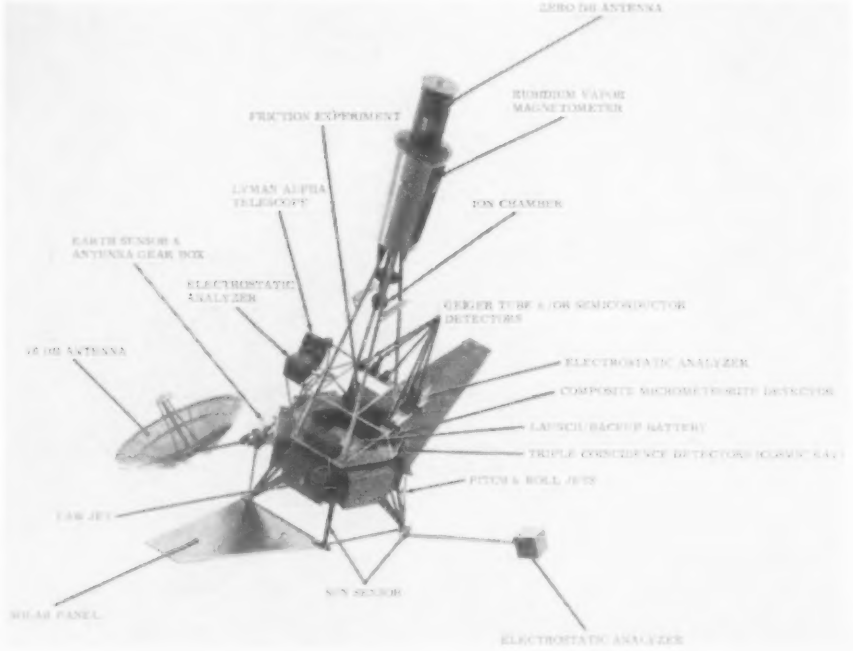
The original intention with the successful American probe, Pioneer V, had been to launch it so that it passed close to the planet, but a delay in the launching date necessitated sending it on an orbit that arrived near the orbit of Venus when the planet itself had moved farther round. Moreover, the desired velocity at launch was not quite reached, so that the transfer orbit did not reach in as far as the orbit of Venus.

The orbit of Pioneer V is shown in Fig. 1. It is an ellipse with a duration of 312 days, or close to 6/7th year. The probe is therefore expected to return to the vicinity of the Earth after six years, having travelled round the Sun seven times.

Pioneer V was communicating with the Earth over a distance greater than 20 million miles on its smaller transmitter of only 5W. It carried a 150W. transmitter for communication over a distance of 90 million miles. The distance separating Venus and Earth at the end of a Hohmann transfer orbit is about 55 million miles, so the data transmission problem is seen to be a fairly straightforward one.

NASA has stated its interest in probing Venus to consist of studies on the following: (1) Atmospheric constituents, pressures and densities, structure, dynamic features. (2) The planetary ionosphere (if present). (3) Interaction of energetic particles with the planet's atmosphere and fields. (4) Electric, magnetic and gravitational fields. (5) Planet's structure and surface features. (6) Extraterrestial life (if present). (7) Conditions in region of transfer orbit.

Some data on Hohmann transfer orbits for Venus and other



This model shows the disposition of research equipment aboard the J.P.L. manoeuvrable space-probe Ranger I, which is scheduled for launching later this year. A version differing primarily in instrumentation is being developed for early planetary missions to Mars and Venus in the Mariner project.

probes travelling within the Earth's orbit are given in Fig. 2. The velocity requirement for entry into a Hohmann orbit is shown in relation to the closest approach made to the Sun by the probe. Orbits of particular interest, in that their duration is a fraction of a year permitting return to the Earth after a reasonably moderate interval, are represented by points on the curve.

The velocity requirement rises slowly at first as the Sun is approached from the Earth, having a value only slightly in excess of the figure of 6.9 miles/sec. required for Earth escape. The value for Pioneer V was 7.0 miles/sec., and for a Venus Hohmann orbit the value would be 7.1 miles/sec. When vehicle performance permits, it will be tempting to use the half-year orbit crossing the orbit of Venus as shown in Fig. 3, and permitting a return to the region of the Earth after one year, the probe having twice travelled round the Sun.

It is, perhaps, difficult to appreciate the acute sensitivity of positioning of probes to small changes in launch velocity from the figures given in Fig. 2. The Astronomical Unit is the mean distance of the Earth from the Sun, and has a value close to 93 million miles. For the Venus Hohmann orbit, the sensitivity of positioning of the probe in the region of the Venus orbit is given by the slope of the curve at that point, and has the value −1.48 miles/sec. per Astronomical Unit.

This looks innocent enough, but in the more familiar units of −0.84 ft./sec. per 10,000 miles it is seen to be an extremely

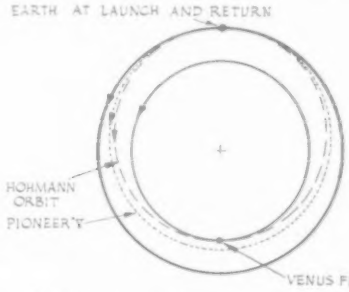


Fig. 1. Hohmann, or minimum-energy, orbit for Venus fly-by. The orbit of Pioneer V is shown for comparison.

sensitive problem. This assumes precise position and orientation at launch. Incorrect orientation also leads to errors at the destination. Obviously, midcourse guidance is essential in practice to ensure positioning satisfactorily close to the target planet.

Where the objective is to return the probe to the region of the Earth and, in addition, to recover it in whole or in part at the Earth's surface, attention must be paid not only to the time taken on the journey, but also to the velocity of the probe after falling into the Earth's gravitational field and just prior to effecting atmospheric entry.

If we ignore the small changes produced by midcourse guidance and any perturbation effects produced by the target planet or other bodies, the atmospheric entry velocity will be equal to the launch velocity, and will have the value shown in Fig. 2 for the appropriate orbit. The severity of atmospheric entry problems increases with entry velocity, and it is still a matter for debate whether there is an acceptable upper limit for this velocity. It seems to be agreed that velocities in the

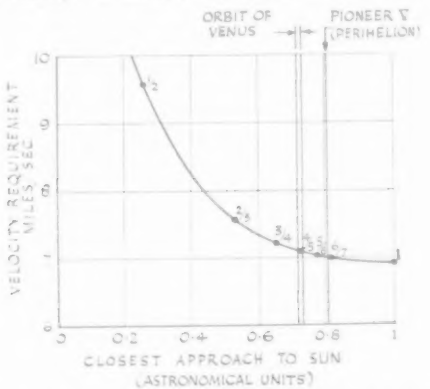


Fig. 2. Velocity requirement for entry into Hohmann orbits with the Earth's orbit. Points on the curve represent orbits of special interest having the duration in years shown.

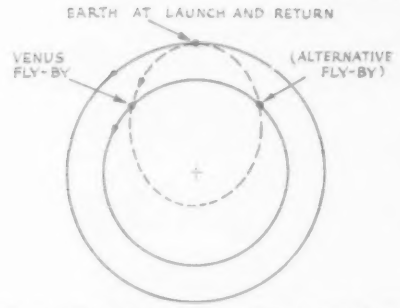


Fig. 3. The ½-year orbit used for a Venus fly-by.

region of Earth escape velocity will be acceptable, but that higher velocities will not.

Should this prove to be the case, then only the lower energy orbits will be favoured, and the half-year orbit will be acceptable only when it becomes practicable to provide means for retarding the probe when it returns to the vicinity of the Earth.

There are, however, alternative ways of combining moderate velocity requirements with modest journey times and reasonable atmospheric entry velocities. An example is illustrated in Fig. 4. This pattern of orbits was selected for a Venus probe mission in a study conducted several years ago by the Western Branch of the British Interplanetary Society, and may be compared with a similar pattern first proposed by Hohmann.

The probe is first launched on a Hohmann orbit to Venus, then accelerates during the Venus fly-by into a new semi-ellipse that carries it outside the Earth's orbit. At the farthest point on this orbit it then accelerates again into the final semi-ellipse that takes it back to meet up with the Earth after an absence of 1.5 years. The total velocity requirement is 9.8 miles/sec., and three velocity changes are called for. Atmospheric entry is effected at 7.0 miles/sec.

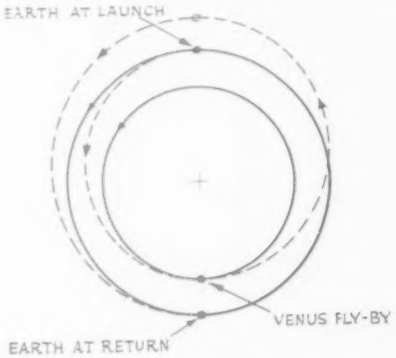


Fig. 4. Venus fly-by with return after 1½ years.

What are the prospects of a probe being launched to Venus during the present favourable period? The United States is apparently not interested in attempting such a shot as it is preparing the Mariner spacecraft for launching by Centaur in the next suitable period for Venus probes in August, 1962. The payload in such a case will be several hundred pounds, and perhaps as much as half a ton.

If a launching were attempted now using Thor or Atlas, a payload of between one and several hundred pounds would be feasible, depending on which vehicle was used. It has already been noted that Pioneer V had a mass of about 100 lb., and that only a slightly higher velocity than that achieved was required to launch it as far as the orbit of Venus.

The Soviet Union could now launch at least half a ton towards Venus. It is curious that they have yet to place a probe in orbit inside the Earth's orbit, and this may prove a suitable opportunity for them to do so. The Soviet Deputy Premier, Anastas Mikoyan, said some months ago that Russia had a vehicle ready to "visit the Sun," and the combination of the opportunity for studies on Venus and the Sun that the launching of such a probe provides may well prove attractive to them.

Either way, it is exciting to contemplate that we are living in an age when man is beginning to plan the exploration of a world that is both relatively near his own in space and promises to be sufficiently like it in some respects to be potentially suitable for colonization, and yet presents an apparently endless vista of new problems for analysis and resolution.

Rocketry at I.C.I.

THE contribution of I.C.I. to the field of solid-propellent rocket technology was emphasized in two papers presented at the recent Rocket Propulsion Symposium at Cranfield. A brief review of this two-day meeting was given in our issue last week.

Particularly interesting was the paper by Mr. J. M. Carter which dealt with "Thrust-axis Control in Solid Propellent Motors." Little information had hitherto been published on this subject in the U.K., but nevertheless the author was able to show a number of interesting results. His paper considered the relative merits and status of several systems including direct mechanical interference with the expanding gases (jet vanes, spoilers, jetavators and tubular extensions of the nozzle), non-mechanical interference with the expanding gases (gas bleeding, secondary gas injection, magnetohydrodynamics) and the movement of the whole thrust-producing apparatus in the form of subsidiary directionable motors and swivel nozzles.

For the control of large motors, Mr. Carter selected the swivel nozzle as the most useful system. Effort at I.C.I.'s Summerfield Research Station, he said, had been concentrated on the ball and socket type nozzle and the rotating nozzle.

In the ball and socket nozzle, illustrated here, the seal is a modified "O" ring in PTFE material and slides on a polished steel surface. At a pressure of 500 p.s.i.g. and a thrust level of 7,000 lb., a maximum torque of 200 lb. in. is required to move the nozzle ± 10° at 0.5 c.p.s., and the whole assembly, including the adaptor to bring it up to the test motor diameter, weighs 17 lb.

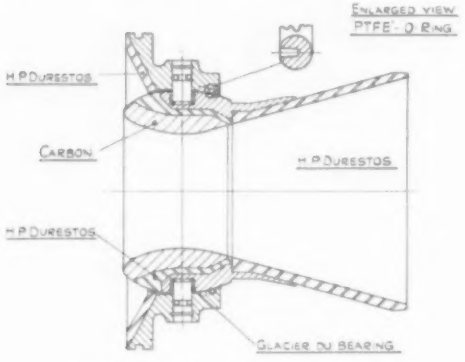
This nozzle is designed as one of a set of four and is arranged to pivot about one axis only, this pivot taking the form of a pair of trunnion pins working in low friction dry bearings and carrying the whole pressure load on the ball. The seal is placed on the outer side of the trunnions in order to remove it as far as possible from the hot gases and solid particles of the gas stream.

The rotating nozzle, developed at Summerfield, is made as a one-piece plastic moulding with a steel insert which acts as the inner race of a deep groove angular contact ball bearing to take the axial and side loads. The seal is again a modified "O" ring in PTFE and bears on the steel insert.

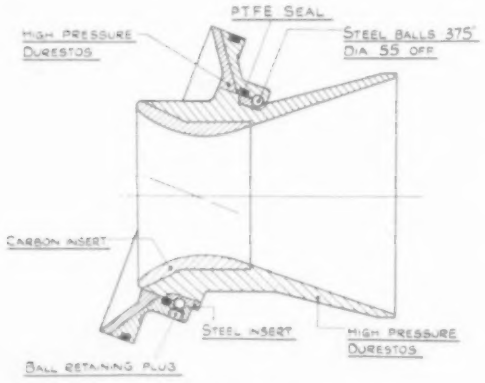
Inclination of the nozzle is such that it must be rotated through ± 30° to give an effective thrust deflection of ± 10° and when moved at 0.5 c.p.s., an actuating torque of about 1,500 lb. in. is required for a nozzle developing 7,000 lb. thrust at 500 p.s.i.g.

The weight of the assembly is 14 lb., including the adaptor required to fit it to the test motor.

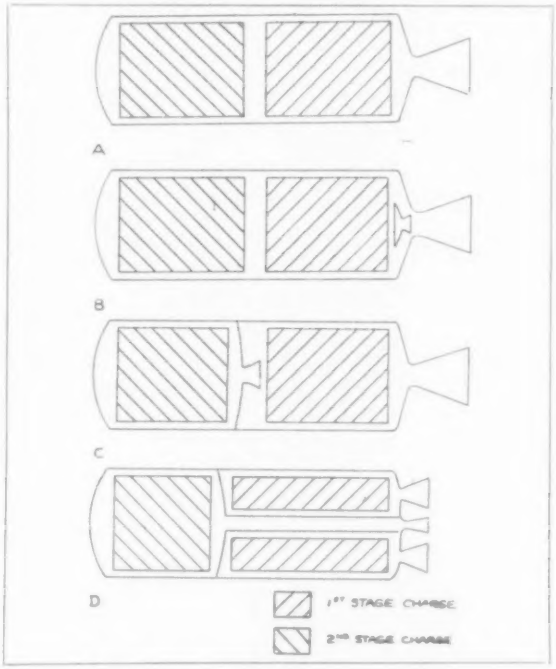
The extra weight to be credited to the nozzles, if fitted to a lightweight motor with an end closure carrying four reinforced apertures to receive them, would be about 8 lb. per nozzle for the ball and socket type and 6 lb. per nozzle for the rotating type. This would be increased by about 30% if the nozzles were for operation at high altitude where expansion ratios of the order of 15 : 1 are required rather than 4 : 1 for which the development nozzles were designed.



Ball and socket type swivel nozzle.



Rotating nozzle.



Types of dual thrust motors. A, Single chamber fixed nozzle; B, Single chamber variable nozzle; C, Double chamber single external nozzle; and D, Double chamber multiple nozzles and transfer tube.

"Solid Propellent Dual Thrust Motors" was the title of the second I.C.I. paper. Its author, Mr. H. M. Darwell, said there were four basic methods of obtaining two thrust levels from a solid-propellent motor. For thrust ratios up to 8 : 1, the system using a single chamber with a fixed nozzle was preferred, this being simple and reliable and showing little, if any, weight disadvantages compared with the other types which have been developed. The possibility of employing a single composite grain gave added attraction to this system.

For thrust ratios in excess of 8 : 1, two types of dual chamber motors were possible. The preferred design, in general, was that using two independent motors in tandem. However, for high-altitude operation during the low thrust stage, the design employing an internal nozzle was worthy of consideration. The latter type had been shown to operate, in principle, in a similar manner to a single chamber, fixed nozzle motor.

The single chamber motor with a variable nozzle was potentially the most efficient way of obtaining two thrust levels, said Mr. Darwell. Although there was no reliable method of changing the nozzle dimensions at present there were indications that a suitable mechanism could be developed.

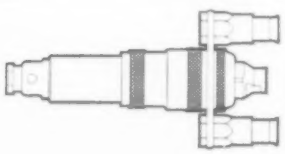
Forty flying years

Albert Plesman founded KLM in 1919. The Royal Dutch Airline is thus the oldest-established of international operators, and pathfinder of many well-used world routes, especially to and through the Far East. Today, KLM flies DC8's through to Australia over trails blazed in part by Plesman's pioneers.
At Sydney AIR BP fuels KLM's new aircraft with the speed and precision that new jet turn-round schedules demand.

Fast flying KLM ROYAL DUTCH AIRLINES *... fast fuelling* AIR BP

THE MANAGING DIRECTOR is most excited about all this Rockets-to-the-Moon business. With reason! Millions of holes in these are being drilled by Desoutter Drills and filled by Desoutter Screwdrivers and Nut Runners. He says any moment these Rockets will be swooshing off with men aboard (and he hopes Ladies too and a Small but well-stocked Bar) to all parts of the Universe. He says he will gladly be a passenger on any of them with a slight leaning towards Venus.

("The old goat!" muttered a faithful employee).



The P.56M Rivet Miller is used by English Electric Aviation Ltd. in the manufacture of the Thunderbird.

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Personal Flying

A SUBJECT of interest to private pilots generally has been highlighted by a recent accident in which an aircraft broke up in mid-air, killing the pilot. At the inquest it was stated that the pilot, Mr. Donald Dillow, had attempted to loop the machine, which was an ultra-light Turbulent from Biggin Hill, with the result that the starboard wing became detached following structural failure.

While this was an extreme case of overstressing an aeroplane which was not built to aerobatic standards, the accident has some general lessons on operating techniques and airworthiness standards of modern aircraft. It may also raise the question of whether the load factors to which light aeroplanes conform are sufficiently high or, alternatively, if the elevator forces are perhaps not high enough to prevent inadvertent overstressing.

In the case of the Turbulent, it is built to the normal B.C.A.R. factor of +3.8 *g*, with an ultimate of about 1.5 times that figure, but, as an ultra-light, it has the almost unprecedentedly low stick force per *g* average of a little over 1 lb. This compares with about 5 lb. per *g* for most modern fighters, and anything up to 50 lb. per *g* for a big jet bomber under certain circumstances. It means that with a mere 6-7 lb. pull on the stick to recover from a dive, a Turbulent pilot could exceed by a fair margin the ultimate positive load factor.

Most light aeroplanes have a stick force gradient averaging at least 10 lb. per *g*, which means that it is virtually impossible to overstress the airframe with normal one-handed operation of the controls. There is a school of thought which maintains that this figure should be a mandatory minimum, but equally there is something to be said for raising the airframe load factors. Modern structures should match current aerodynamic standards as regards their efficiency among present light aircraft. Even some of the most popular designs flying in very large numbers are sometimes perilously near the bone, in terms of strength from the aspect discussed.

* * *

McAlpine Aviation, the business flying division of Sir Robert McAlpine and Sons, the civil engineers, are expanding their executive operations by making available for lease three six-seat Piaggio P.166 light twins. These will be available, complete with pilots, at a set fee for a block of several hundred flying hours, and are likely to be popular as a means for companies to acquire experience of executive flying without going into the expense and complications of buying an aircraft straight away. The Piaggios are based at Luton Airport, where McAlpine Aviation operate a sales, maintenance and executive flying unit.

* * *

To avoid confusion, the Morane Saulnier M.S. 880 Rallye Club, which has a 90 or 100 b.h.p. Continental engine, has been redesignated the M.S. 885 Super-Rallye in its 145 b.h.p. version. By Dec. 25, 150 firm orders for this three-seater had been received, one-half from France, and the remainder from 16 different foreign countries.

The second prototype, to production standards with a swept fin, is due from the Tarbes factory this month, and the third, which will be the 145 b.h.p. prototype, is to fly in February. The first four production aircraft will follow in April, and by July, output should be stabilized at 30 Rallyes per month. In all, 250 are being built, and 300 engines have so far been ordered from Continental: 150 of 145 b.h.p., 125 of 100 b.h.p., and 25 of 90 b.h.p. Delivery begins in March.

NEW FROM ITALY.—Selected as the standard Italian club trainer and tourer, the two-seat Aviamilano P-19 is of mixed construction, with a 90 b.h.p. Continental engine.

Gliding Notes

by Dr. A. E. Slater

"I DECLARE Perranporth, you Navigate," was the title of an entirely novel type of lecture given by Ann Welch at the Kronfeld Club. "Bring your maps," we were told, and that was the only clue until we got to the lecture room and found Ann's lecture to consist of a series of colour photos, shown on the screen, together with information on the assumed time, direction of view and height from which they were taken at various points along the route.

The exercise turned out to be far more difficult than the real thing, except perhaps for Lasham members who had made many competition flights or Gold "C" distance attempts along the Perranporth trail already. Few of the pictures overlapped, and hardly ever did the photographer take more than one picture from the same place. Moreover, they were nearly all taken in a north-westerly direction, no doubt because the Auster in which the photographer had travelled has side-by-side seating.

No sooner was Lasham out of sight than I was lost, and the only places I subsequently recognized were Yeovil railway junction and the estuaries south of Exeter and north of Padstow. On the colour slides, the shapes of woods stood out best, except where they got mixed up with cloud shadows; but there was no time to compare them with the map before the next slide came on. Railways did not show up as well as they do in practice. But what one missed most of all was the ability to look all round the compass, as one would in real life.

Nevertheless, it was an exceedingly good exercise, because if you can navigate from Lasham to Perranporth with a series of disconnected unilateral views such as were shown on the screen, you should have no trouble at all with a real landscape. It was a brilliant idea.

* * *

IN Yugoslavia a wave-soaring expedition was made to the neighbourhood of the Pljesivica Mountains during October and November. Boris Cijan writes that they had good success, and the greatest gain of height was 8,600 m. (28,215 ft.).

As a result of a two-year trial of a new training method, Cijan adds, it has been decided in Yugoslavia to replace all sailplanes eventually with two standard types only, a two-seater and a single-seater. A competition is being prepared for the design of these two types. The two-seater can be of any span, but the single-seater must conform to OSTIV requirements for the Standard Class with a span of 15 m.

* * *

FIGURES for private aviation in West Germany have been issued for 1959, and show a total of 132,000 hours for gliders and slightly less, 130,000 hours, for motor-driven machines. By last spring there were 1,290 single-seater and 930 two-seater sailplanes in the country, while 17 balloons had made 223 motorless flights in the past year. About 60% of the sailplanes are amateur-built.

The French total for the same year was 100,000 hours in sailplanes, the most serious damage to pilots being one broken leg and one broken ankle; whereas aeroplanes, with 300,000 hours, were responsible for 35 fatalities and 70 serious injuries.

Belgium has now two pilots with all three Diamonds additional to their Gold "C" badges. The latest is Roger Meulemans, who set up a national distance record with 572 km. (355 miles) from Brussels to Nantes, and now, with a climb of 21,000 ft. to an absolute altitude of 25,850 ft., at Issoire in France on Dec. 3 last, has beaten the national height record.

* * *

A 1938 Kranich is on its way from Holland to New Guinea, where it will be the first sailplane in the latter country. A gliding club has been formed there. An early glider in that part of the World was a Prüfling built by a German in Sumatra in 1937, mostly of native materials.

* * *

ACCRA Gliding Club will lose some of its most experienced members temporarily in April, because they are taking "home leave" in order to attend the National Championships at Lasham from May 13 to 22. They are hoping to share the use of two sailplanes in the contest.

Another would-be overseas competitor, though he is not overseas at the moment, is Mr. A. B. Araoz of Argentina, who is at present at Nuffield College, Oxford. But he will need a sailplane and hopes somebody will hire one out to him, preferably a Skylark 3, the type which he flew to 13th place in the Open Class at the 1958 World Championships. He has come second in the Argentine Championships on two occasions, and has the Gold "C" with three Diamonds.

Industry Record

Copper Electroforming

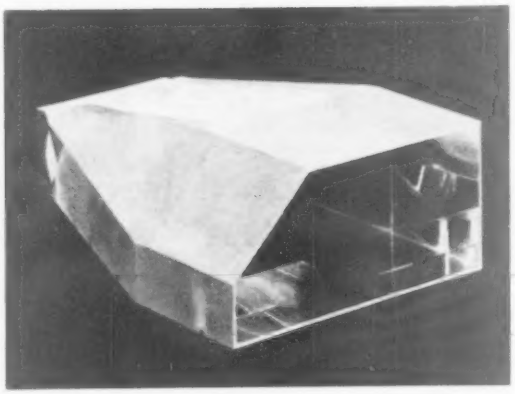
Decca Radar, Ltd., have developed a copper electroforming service, known as the Deccaform process, for the production of complex internal shapes.

Based on the electro-deposition of copper, using both low temperature soluble and stainless steel formers, the process produces parts of high dimensional accuracy and good electrical properties. Internal shapes with re-entrant cavities can be accurately made in one piece.

An important feature of the process is that any metals on which copper can be satisfactorily deposited may be used as inserts over which the copper is grown. They then become an integral part of the finished article. Brass inserts can be used and are commonly employed for posts, probes, couplings and flanges.

Because of the high dimensional accuracy and fine internal finish, electroformed transmission line parts are stated to show a marked superiority in their electrical characteristics to fabricated or cast components.

Parts of complex shape up to approximately one cubic foot in volume can be produced with wall thicknesses up to 0.5 in. Current production includes such items as rotating joint housings, duplexers, waveguide switches, launching sections for noise sources and magnetrons, as well as a comprehensive range of bends and twists for the X and S band.



A complex transmission line section produced by the Deccaform process.

The use of microwave equipment in aircraft often brings with it transmission line problems, especially where a rectangular waveguide has to be employed. The use of the Deccaform process allows tailor-made waveguide runs to be produced to suit individual aircraft structures, and the installation engineer no longer has to consider the limitations of standard waveguide sections.

It is often necessary to terminate hollow copper conductors carrying both electrical energy and gas or fluid coolant. A Deccaform component can be developed to suit any such application, providing a low resistance electrical termination and having an ideal internal form for the flow of liquid or gas with a minimum of pressure drop.

Electro-chemical Blade Machining

Considerable economies in the finish-machining of turbine and compressor blades for gas-turbine engines are made possible by an electro-chemical process which is being introduced into Britain by Metachemical Processes, Ltd., of Crawley, Sussex. This technique has been developed in the U.S. by an associated company, Steel Improvement and Forge Co. (Sifco) of Cleveland, Ohio, working in collaboration with the Battelle Memorial Institute of Columbus, Ohio.

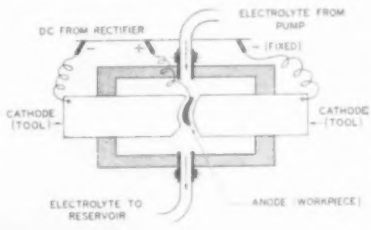
Sifco has finish-machined more than 15,000 blades by this technique since it was introduced last year. Its main customers are Pratt & Whitney and General Electric.

The process depends on electrolytic removal of metal by anodic dissolution. The workpiece is connected to the positive terminal of a DC current source, forming the anode. Specially shaped cathodes are connected to the negative terminal.

When electrolyte is pumped between the workpiece and the cathodes, the circuit is completed and metal is removed from the workpiece without the cathodes being affected. As metal is removed, the cathodes are moved towards the workpiece so that a small gap of about 0.005-0.010 in. is maintained between them. In this way the workpiece takes up the required mirror-image contours of the cathode tools.

This process offers the greatest economies when it is applied to production of shapes which cannot easily be machined and to advanced alloys which are very difficult to handle by conventional techniques. It is particularly suitable for turbine-blade finish-machining and also for the drilling of holes in very tough materials.

Holes can be drilled in turbine blades of Nimonic alloy to form air cooling ducts. When the process is used for drilling, a tube forms the cathode and electrolyte is forced down it, returning through the gap between the tube and the side of the hole.



In the U.S. the process has been developed for a range of metal-removal operations. It is suitable for turning, internal grinding, milling, parting off, internal helical grooving, drilling of deep and multiple holes, trepanning and die-sinking.

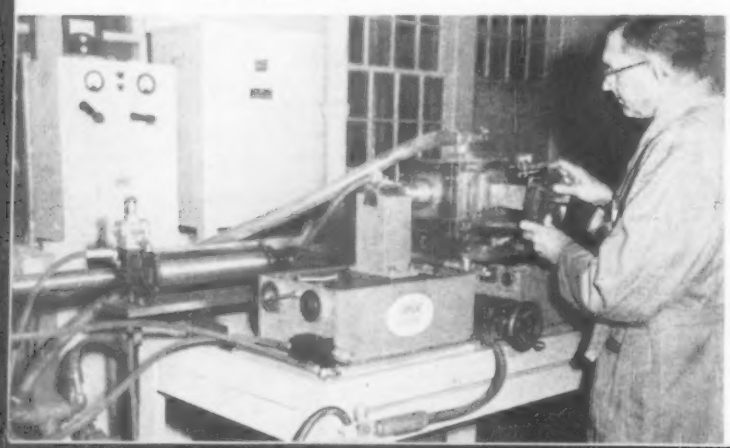
In Britain, Metachemical Processes will concentrate initially on its use for the finish-machining and drilling of holes in turbine blades. Both Rolls-Royce and High Duty Alloys are stated to be very interested in this application.

The process will be applied to blades which are forged to within about 0.020-0.030 in. of the dimension required; this represents a big economy in forging time. They can then be finished to an 0.003-in. tolerance by electro-chemical machining in less than five minutes per blade. Leading and trailing edges as thin as 0.005 in. can be achieved.

Metachemical Processes will make machines for operation under licence by their customers. They will be asked to supply the cathode tools and the company will then build these into a suitable machine and prove it before delivery; thereafter it will provide a technical service to its customers. It is estimated that the installation of a machine, its power supply and controls should cost under £5,000.

Initially the company will supply machines only to customers that have a chemical laboratory and are thus considered technically competent to handle the technique.

In the U.S. the electrolyte used costs about two cents a blade, but is changed every few minutes. Metachemical Processes intends to use somewhat more expensive electrolytes which would need to be changed only at the end of each eight-hour shift. Allowing for the time saved, it is considered that this approach will be cheaper overall.



BLADE FINISHING.—Principle of the Sifco electro-chemical machining process is shown above; on the left is one of the machines used for blade shaping.

Correspondence

From The Master of The Guild of Air Pilots and Air Navigators:—

Unified Air Traffic Control in the U.K.

"THE Pattern of the New York Collision . . ." "Shocking Statistics . . ." "The Busiest Airports. . . ." Such was the sequence of headlines over articles forming the major part of Air Transport news in THE AEROPLANE AND ASTRONAUTICS of Jan. 6. The first quotes the A.T.C. tape recording of the New York disaster. The second draws attention to the high fatality rate in accidents to commercial aircraft in 1960. The third states that the U.K. has a long way to go yet before its airspace reaches a point of dangerous saturation, even in main terminal areas.

My recent appeal in *The Times* for the immediate introduction of a unified air traffic control system in the U.K. was based on this Guild's conviction that H.M. Government has not apparently realized the gravity of this problem. Air traffic control has not kept up with aircraft development, and at the present leisurely pace of progress in A.T.C. the point of "dangerous saturation" will be with us before it is possible to avoid repetition here of the pattern of the New York collision and future shocking statistics.

It is relevant to this that pilots find little difference *at times* between traffic density on U.S. airways and sectors in this country. But placing L.A.P. in a world list according to annual aircraft movements is not relevant, neither is it relevant to the question of air traffic control—however few aircraft are flying *at any one time*, there is hazard if there is not one authority controlling them.

The Parliamentary Secretary to the Minister of Aviation in reply to a question on Dec. 21 (Hansard, column 178) said that the Ministry did not propose to take any action with regard to unified air traffic control as he believed the right policy for the U.K. was "integration." This is a dangerous word. Integration means discussion; discussion means delay, and possibly argument, both of which can be fatal to safety.

There must be an overriding authority to make decisions; we have a high regard for Mr. Rippon, but his statement, in our opinion, results from compromise because two parties are not prepared to give way to each other—at present it appears that this thinking will be passed on to the controllers, with results which I have already described. Reference to the tape recording quoted in your second article proves what can happen.

The Guild of Air Pilots and Air Navigators has sent to the Ministry of Aviation some proposals for the prevention of collisions in the air. In making these proposals we are thinking of safety for all users, for we believe they will result in greater freedom for all, including pilots of light aircraft and gliders.

Incidentally, I am reliably informed that in his esoteric search for thermal upcurrents recently a glider pilot crossed a U.K. airway no less than three times; any one of these might have been lethal for several score of innocent airline passengers. Freedom does not mean liberty to imperil the safety of others.

Any accident is one which could have been avoided, and now is the time to take avoiding action. We hope therefore that the Minister will act swiftly to implement our proposals, which we will publish shortly.

London, W.1. K. G. BERGIN.

Scimitar Blades and Manpower

IN the extract from Mr. C. G. Grey's memoirs, headed "Recalling some Early Days at Brooklands" (Dec. 30 last), Mr. Grey referred to the scimitar-bladed propeller which worked equally well with different engines and craft.

He said he did not recollect which way it turned and no one seemed to know why it was more efficient than the standard propellers of the period.

Surely, if the aeroplane is not designed to fly backwards, the photograph shows clearly from the position of the leading blade-edge that the tip leads the rest of the blade and is not swept back.

The reason for its efficiency, I suggest, is due to the fact that the normal outward flow of the boundary layer, caused by centrifugal action, is prevented by the reversed flow *from* the tip. More air is passed through the blades and ejected backwards in much the same way as the annular ring makes a ducted fan more efficient than an airscrew.

Of course, this is not adaptable to variable pitch but should be a useful source of study for manpowered aircraft enthusiasts.

But, why am I telling my rivals this?

Brixton, S.W.2. H. R. BARNARD.

Scimitar Blades and Single-blades

I AM really glad that Mr. L. Douglas Gillies (Jan. 6, 1961) has brought to notice the prophecies of the late C. G. Grey. His editorials were full of prophecies. On the strength of this I suggest that the editorials of C.G.G. should be published in book form; and that something should be done quickly about publishing his manuscript "Bats from my Belfry," thereby rendering a great service to aviation history. You have only to read his editorials to find that they are full of vitality and information—no dull reading here—and what a fighter he was!

Referring to the extracts of "Bats from my Belfry" he mentions the scimitar blade which (to quote) "so far as I can remember nobody ever made another one like it." I would hate to dispute with the late C.G.G. but I have a hunch

Wroundabout

"Follow that bus!" If an idea of Brazil's airline, Varig, catches on here in London our colourful buses will have some rivals. Varig have turned a bus into a mobile ticket office, painted it in their colours and have sent it round the streets of Brasilia, the new capital, with great success. At scheduled stops, or by chasing the bus, citizens can get their airline tickets from the agent inside, who has a radio link with their reservations centre. A clever publicity idea, too. Passing thought: If all London's airlines put similar buses into our traffic jams, they could further slow up their own passenger coaches to the airport.

*

Always something wrong. On that subject, the road transporter bridge over the River Mersey is being replaced, so Liverpool Airport will lose its built-in delay system, which has held up many a passenger on his way to catch a service. But airport porters (airporters?) will miss the tips handed out by grateful latecomers for having their passage speeded through the processing process.

*

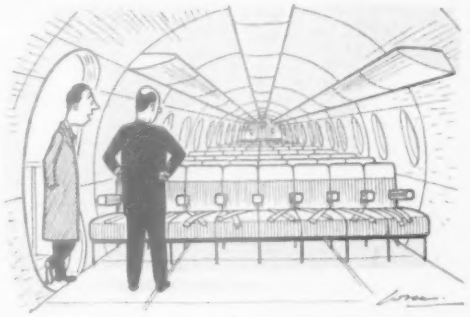
G-ADSR! Mr. H. J. Wilkinson, a Shell airfield inspector, saw his favourite Viscount during a recent visit to Italy—its registration: I-LIFT.

*

"The International Air Transport Association? I don't think I've heard of them—oh, you mean *IATA*!"

*

Competition Corner. This little drawing seemed to me to have so many captioning possibilities that I decided to let you wreaders have a bit of fun with it. The sender of the best caption gets a Wrendering original, signed.



*

Progress

Jet airliners now in service round the World are twice as fast, three times as capacious, four times as heavy, six times as powerful, and eight times as expensive as the airliners of ten years ago.

*

Jet engine noise suppressors reduce a jetliner's payload capacity by the equivalent of about two men and a boy.

*

The propeller equipment for the three Franco-German Transall C-160 transport prototypes, each powered by two Tynes, will cost half a million pounds.

by Wren

Correspondence . . . .

that way back in 1944-45 I examined another scimitar blade which was propelled by an enormous radial engine. In the same article there was shown a Cessna C37 "Airmaster" with a *single*-blade Everell airscrew, and this article I am certain appeared in one of the issues of *The Aeroplane Spotter*.

Billesley, Birmingham, 14. MAURICE AUSTIN.

[As technical editor of THE AEROPLANE in the pre-1939 era I can assure Mr. Austin that I did a description of the Everell single-blade airscrew long before 1944.—T.J.]

Cantilever Comment—1

THE article by Air Cdre. H. V. Rowley (Dec. 23 last) was particularly good, but I have something to mention about the Fokker Dr. I. Air Cdre. Rowley wrote that the struts which connect the wings of the Dr. I were perhaps fitted to obtain an orthodox appearance.

Fokker built the first prototype of the Dr. I without the interplane struts; this prototype carried the experimental number V.3. The following prototype V.4 did carry the interplane struts because there was some vibration, owing to the method of fastening of the wing to the fuselage.

The V.3 was not the first cantilever machine built by Fokker; the first was the V.1 "Floh" (Flee), which first flew in December, 1916. The machine had a thick parasol wing so that it could be dismantled in a few minutes and towed behind a truck.

The Fokker Dr. I was of original Fokker design, for the drawings were completed before the first Sopwith Triplane was shot down intact. It is said that the experimental machines were not of Fokker's design, but of Mr. Reinhold Platz.

The cantilever wing was not of original Fokker design, for in 1915 the Fokker concern was joined with the Junkers company, the experts on all-metal cantilever aircraft. The first cantilever machine of Junkers was the J.1 "Blechesel" (registration 251/15), first flown Dec. 12, 1915, from Döberitz by a man named Mallinkrodt. The speeds attained were in the range of 170 km/hr. (105.5 m.p.h.) faster than any aeroplane then flying. This was about a year before the Dr. I appeared! The machine was preserved in the Berlin Air Museum destroyed in 1944. After the J.1 a great range of cantilever aircraft was produced by Junkers.

I am trying to list all German aeroplanes built from the earliest days till 1945 inclusive; perhaps there are readers who are doing the same.

Rotterdam, Holland. K. KORT.

Cantilever Comment—2

I READ Air Cdre. Rowley's article "Cantilever Story" (Dec. 23 last) with much interest and should like to offer a few comments.

Surely the Wright brothers did not select the biplane form because "it was a relatively simple matter to calculate the stresses and strains on the spars, struts and wires in the wings," but for lightness. In fact the full solution to the stressing problem of a Warren girder with a distributed load was not known until 1916 or thereabouts. Bolas, I believe, was one of the luminaries responsible for the theorem of three moments in this application. The resolution of a pure cantilever seems child's play by comparison.

The long vogue of the military biplane was due, at least in this country, to the official attitude. Only the biplane became acceptable from a certain date. Designers were allowed no choice.

The author speaks appreciatively of Hubert Latham and his Antoinette monoplane. I saw them both as a small boy in 1910. Latham took off from Port Meadow, Oxford, and flew to Brooklands. When long after I saw the Antoinette in South Kensington Museum I recognized it as the same—or its twin brother.

If the struts in Fokker's triplane had adequate fixity at the spars and were stout enough in themselves they would have increased spar stiffness to some extent by redistributing the bending. Whether it was so or not I cannot say, but that would seem the only adequate reason for fitting struts and no wires.

Lastly, the Air Commodore wonders whether we were not better off with horses. I support him in that, for all the good some of this "progress" is doing us—and we might get better vegetables.

Cheltenham. KENNETH J. KEY, A.F.R.Ae.S.

Publication Received

Die Deutschen Flugzeuge, 1933-1945. By K. Kens and H. J. Nowarra. This handbook is intended to provide details of all German military aircraft developed for the Luftwaffe from 1933 to 1945, and includes many of the fascinating WWII projects. The main text describes the aircraft of the manufacturers in alphabetical order, and is illustrated by side-view or three-view silhouettes. Over 450 photographs are grouped on better paper in an appendix and other sections tabulate the aircraft data and describe engines, missiles, guns and bombs. A knowledge of German is necessary to get full value from this useful work, but key words are given in English also to make at least the basic data understandable. 816 pp.: 5¼ in. by 7¼ in. Illustrated. Published by J. F. Lehmann Verlag (Paul-Heyse-Str. 26/28 München 15, W. Germany). Price DM.68.

Aviation Calendar

Jan. 20

London.—R.Ae.S. Man Powered Aircraft Group lecture, "Gliding and Manpowered Flight," by Lorne Welch, in the Lecture Theatre, 4 Hamilton Place, W.1, at 19.00 hrs.

London.—Institute of Navigation lecture, "Presentation of Height Information in Aircraft," by A. Stratton and K. R. Monick, at the Royal Geographical Society, 1 Kensington Gore, S.W.7, at 17.15 hrs.

Jan. 21

London.—British Interplanetary Society film show, in the Science Museum Lecture Theatre, Exhibition Road, S.W.7, at 18.00 hrs.

Jan. 23

Coventry.—Lanchester College of Technology Rocket Engine Technology lecture course, "Trajectories and Requirements for Rocket Propelled Vehicles," by M. S. S. Hunt, at the College, at 19.00 hrs.

Prestwick.—R.Ae.S. Glasgow Branch Graduates' and Students' Section lecture, "Building a Light Aircraft," by Dr. Roche, at Scottish Aviation, Ltd., Prestwick Airport at 19.30 hrs.

Jan. 24

London.—R.Ae.S. lecture "Problems of Erosion and Impact," by Dr. R. N. C. Strain, in the Lecture Theatre, 4 Hamilton Place, W.1, at 19.00 hrs.

Middlesbrough.—Society of Instrument Technology Tees-side Section lecture, "The Experimental Investigation of Space," by Dr. P. J. Bower, in the Cleveland Scientific and Technical Institute, Corporation Road, at 19.30 hrs.

Jan. 25

Weybridge.—R.Ae.S. Branch lecture, "The Exploration of Outer Space," by J. A. Ratcliffe, in the Apprentice Training School, Vickers-Armstrongs (Aircraft), Ltd., at 18.00 hrs.

Jan. 26

Wirral.—Society of Instrument Technology Chester Section lecture, "Satellite Instrumentation," R. C. Jennison, in the Lecture Theatre, Administration Building, Associated Ethyl Co., Ltd. Oil Sites Road, Ellesmere Port, at 19.00 hrs.

Company Notices

NEW COMPANY

CUSHIONCRAFT, LTD. (678,899).—Private co. Reg. Dec. 28. Cap. £100 in £1 shs. To acquire by original grant or by transfer or assignment or otherwise letters patent, brevets d'invention, licences, concessions, secret processes and inventions relating to and in respect of ground effect and hover machines. Sols.: Beaumont and Son, 380 Gresham House, Old Broad Street, E.C.2. Reg. off.: Bembridge Airport, Isle of Wight.

CHANGE OF NAME

Portsmouth Aviation Developments, Ltd. (459,819). The Airport, Portsmouth.—Name changed to Portair Products, Ltd., on Jne. 27, 1960.

New Patents

APPLICATIONS ACCEPTED

861,121.—**Wyllie, D. J.**—"Ballast weight."—Nov. 15, 1957. (Nov. 10, 1956.)

861,230.—**Vickers Aircraft Holdings, Ltd.**—"Aeroplanes."—May 18, 1956. (Jne. 6, 1955.)

861,342.—**Fonden, P. B.,** and **Walander, K. O. T.**—"Raising and lowering appliances for aeroplane arresting apparatus."—Aug. 8, 1959. (Aug. 28, 1958.)

861,298.—**Power Jets (Research and Development), Ltd.**—"Aircraft."—Sept. 27, 1957. (Oct. 2, 1956.)

Printed specifications of the above will be available on Feb. 15, 1961, and the opposition period will expire on May 15, 1961.

861,407.—**Blackburn Group, Ltd.,** and **Bradbury, C.**—"Aircraft of the rotating wing type."—Aug. 11, 1959. (Feb. 12, 1959.)

861,618.—**Construzioni Aeronautiche Giovanni Agusta S.p.A.**—"Helicopters."—May 13, 1959. (Mar. 27, 1959.)

861,480.—**Hawker Aircraft, Ltd.**—"Aircraft."—Feb. 4, 1959. (Jne. 2, 1958.)

861,519.—**Soc. Bertin and Cie.**—"Ejectors or jet apparatus."—Jan. 19, 1959. (Jan. 21, 1958.)

861,761.—**Associated Electrical Industries, Ltd.**—"Aircraft auxiliary installations."—Apr. 4, 1957. (Apr. 4, 1956).

Printed specifications of the above will be available on Feb. 22, 1961, and the opposition period will expire on May 22, 1961.

862,001.—**United Aircraft Corporation.**—"Helicopter controls."—Apr. 10, 1959. (May 13, 1958.)

862,032.—**Power Jets (Research and Development), Ltd.**—"Aircraft."—Sept. 21, 1959. (Oct. 3, 1958.)

861,819.—**Boeing Airplane Co.**—"Noise suppressor and thrust reverser for jet propulsion engines."—May 29, 1958 (Jly. 29, 1957.)

Printed specifications of the above will be available on Mar. 1, 1961, and the opposition period will expire on Jne. 1, 1961.

Personal Notices

BIRTHS

Doherty.—On Jan. 9, at Windlesham Maternity Home, to Thelma, wife of Sqn. Ldr. F. W. Doherty—a daughter.

Ferenczy.—On Jan. 6, at R.A.F. Hospital, Akrotiri, Cyprus, to Beryl (*née* Cole), wife of Flg. Off. G. I. Ferenczy—a son.

Fuller.—On Jan. 8, at R.A.F. Hospital, Wroughton, to Elizabeth (*née* Clarke), wife of Wg. Cdr. G. D. Fuller—a daughter.

Gardham.—On Jan. 3, at R.A.F. Hospital, Ely, to Rosemary, wife of Gp. Capt. M. M. Gardham—a son.

Grant.—On Jan. 10, at R.A.F. Hospital, Changi, Singapore, to Hilary (*née* Beck), wife of Flt. Lt. Alistair Grant—a son.

DEATHS

Buss.—On Jan. 2, Air Cdre. Kenneth Caron Buss, O.B.E.

Racine-Jaques.—On Dec. 31, Henry Racine-Jaques, a pioneer aviator and aircraft designer.

DART Herald

Pressurised civil or military jet-prop transport; 56 passengers or over 6½ tons of freight or combination of both at 275 m.p.h. for 850 miles; operates from 1000-yard grass airstrips; built for long life and easy maintenance; 1d a passenger-mile economy.

. . . to see the Herald leave Leh

Leh, in a Himalayan bowl, is over 10,000 feet above sea level. But the route-proving Herald cut an engine at take-off to climb away over the monastery towards the mountains.

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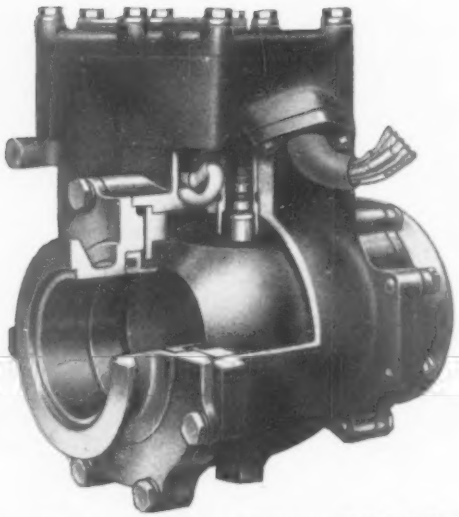

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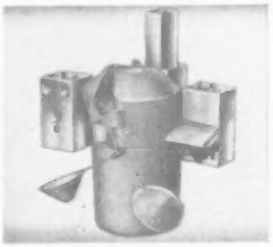

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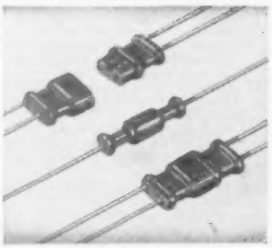

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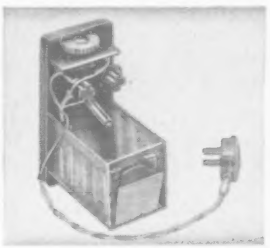

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RATES—1/- per word (minimum 12 words 12/-). Each paragraph charged separately and name and address must be paid for. Semi-displayed setting £3-17-6 per single column inch. Centred lines 22/6. Series discounts of 5% for 13, 10% for 26 and 15% for 52 consecutive insertions, allowed to trade advertisers.

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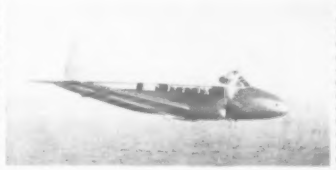

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Candidates should be between the ages of 35 and 50 years, and should hold A., B and C Aircraft Maintenance Engineers Licences appropriately endorsed for light aircraft. Preference would be given to candidates holding X licences on instruments and having administrative and supervisory experience. An endorsement to cover the maintenance on De Havilland Dove aircraft would be an advantage.

Appointment will be on contract for one tour of 12-18 months in the first instance with prospects of extension. Salary according to qualifications and/or experience, £1,944-£2,196 p.a. (including Inducement Addition). Gratuity of £150 p.a. for satisfactory service. Free passages for officer and wife. Liberal leave on full pay. Quarters at low rent. Income tax at low local rate. Assistance towards children's passage or grant whilst separated.

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1. ASSISTANT CONTROLLER—

preferably with current Certificate of Competency and recent flying experience—Salary within Grade APT I £645 x £35 to £815 according to experience.

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Applications together with names of two referees should reach the undersigned at the Town Hall, Luton—not later than January 30, 1961.

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Town Clerk. 570-8

DOVE A and C licensed engineer required, permanent employment offered. Write: Sir Robert McAlpine and Sons, Ltd., Luton Airport, Luton, Beds. 570-6

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DUTIES: (Position No. 68) Responsible to the Group Leader (Applied Mechanics) for theoretical and experimental research in the fields of elasticity, plasticity and creep.

QUALIFICATIONS: Honours degree in engineering with a major in structures, or in arts or science with a major in applied mathematics. Some years research experience in the above field of work.

NOTE: Applicants who do not have the necessary experience may initially be employed as Scientific Officer, Grade 3 (£2,005-£2,265) and at a later date may be advanced to Senior Scientific Officer (£2,460-£2,655) subject to satisfactory progress.

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SALARY: £1,510-£1,895 (Australian Currency).

DUTIES: Carry out theoretical and experimental research in the fields of elasticity, plasticity and creep.

QUALIFICATIONS: Honours degree in engineering with a major in structures, or in arts or science with a major in applied mathematics. Some research experience an advantage.

CONDITIONS: These positions offer Permanent Appointment to the Commonwealth Public Service and the successful applicant will be required to contribute to the Commonwealth Superannuation Scheme on confirmation of Appointment. Under specified conditions, first class air/sea transport for the Appointee and dependants (wife and dependent children) will be provided by the Commonwealth. **Alternatively** consideration may be given to a three (3) or five (5) year contract of employment in Australia. In this case the Commonwealth will bear the cost of return fares, together with the cost of removing the successful applicants' furniture and effects up to a maximum cost of £500 (Australian), £250 each way.

APPLICATIONS: Forms obtainable from Senior Representative (AV.101/7), Department of Supply, Australia House, Strand, London, W.C.2, with whom completed applications should be lodged by 6th February, 1961.

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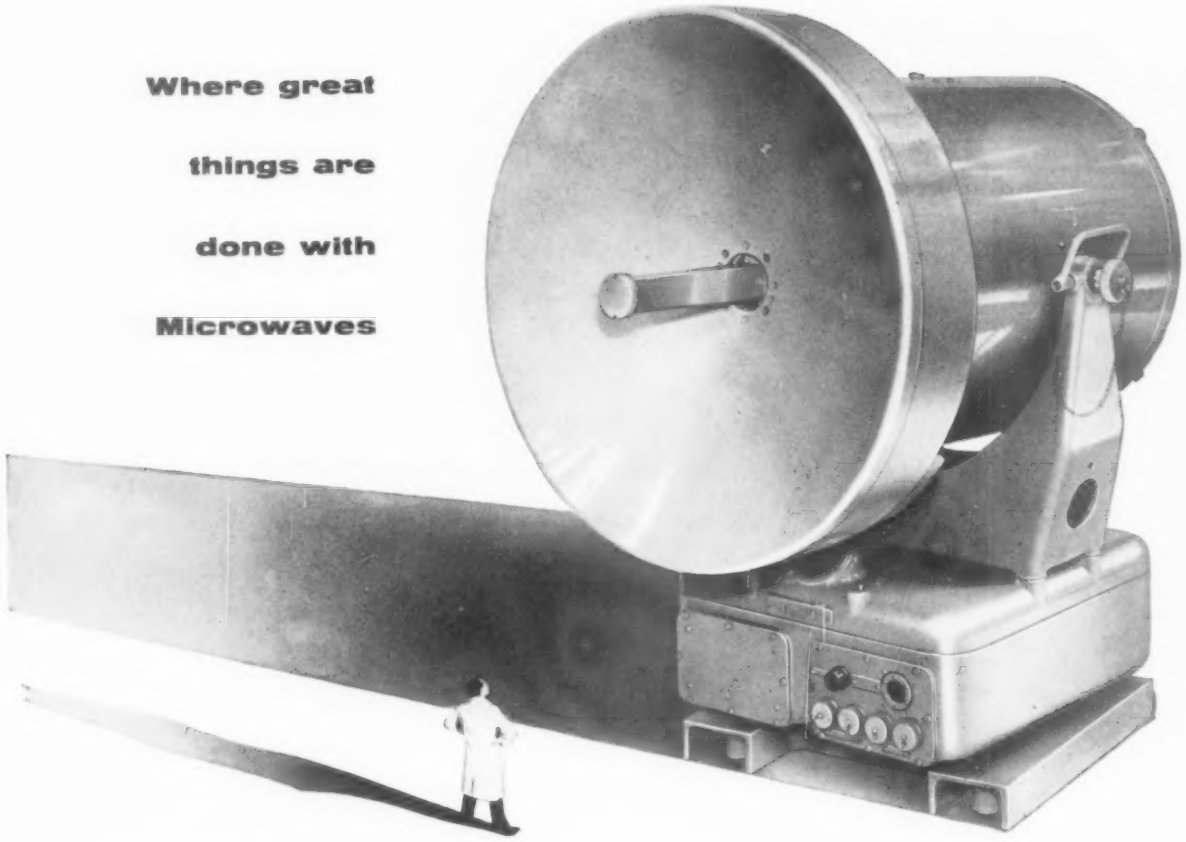

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